

Information Manual and Flight Handbook



Microsoft® Flight Simulator

Information Manual and Flight Handbook

**For IBM® Personal System/2®,
IBM PC/AT®, and
Compatibles**

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Welcome

Welcome to Microsoft® Flight Simulator. Flight Simulator is a fourth-generation, real-time flight simulation program that pilots of all ages and levels of experience will enjoy. The simulation considers 47 important aircraft characteristics and includes an out-the-window, three-dimensional, dynamic flight display, extensive flight controls, and minimum Visual Flight Rule (VFR) and Instrument Flight Rule (IFR) instrumentation as specified by the Federal Aviation Administration (FAA).

Graphics drivers Flight Simulator features detailed graphics that closely simulate a pilot's actual perspective. High-precision graphics drivers present solid-modeled images with hidden surface elimination and surface shading, and much greater accuracy than any previous microcomputer Flight Simulator. Graphics detail and quality are adjusted to make the best use of whatever display adapter and monitor you use (CGA, EGA, VGA, Personal System/2, or other).

Microprocessor This fourth-generation simulator also makes the best use of your system's microprocessor. Independent modules are loaded for 8086-type systems (including 8088, 186, and 286) and 386 systems to use the high performance instructions unique to each processor.

Flight Simulator's world Flight Simulator's "world" is more than 10,000 by 10,000 miles square, with a resolution of about one one-hundredth inch. The world encompasses the entire continental United States and extends into Canada, Mexico, and the Caribbean. The "populated" world consists of five areas and includes 118 airports.

Flying lessons As a convenience to new pilots, flying lessons with varying degrees of difficulty are provided. If you have never flown before, you can use the basic lessons and the easiest flight mode to learn the fundamentals of flight control. When you have mastered the basics of flight, or if you are already a seasoned pilot, you can select more realistic and difficult modes to simulate sophisticated flight maneuvers.

Controlling environmental conditions In all modes, except Entertainment modes, you can control environmental conditions such as wind, season, clouds, time of day, and turbulence. You can also set a reliability factor that determines how frequently flight problems arise. You can begin or resume flight from a series of interesting prerecorded flight situations, and you can even set up test situations and record your flights for playback at a later time.

Flight Simulator's aircraft Flight Simulator simulates a single-engine, high-performance, propeller-driven aircraft of the Cessna 182 class; a business jet of the Gates Learjet 25G class; and a sailplane of the Schweizer 2-32 class. The Cessna 182-type single-engine prop aircraft is an ideal plane for pilot training because it has climb performance and speed that keep a pilot busy, especially on landing approach. This aircraft's simulation is designed for realism and presents the feeling of flying in a real-life situation.

The business jet simulation is designed for fun. The aircraft is easy to fly and aerobatic, and lets you see what it is like to fly at 450 knots at an altitude of 45,000 feet.

The sailplane simulation lets you experience soaring using thermals and ridge lift.

Aircraft design Flight Simulator now lets you design your own aircraft. The experimental aircraft is initially a small prop plane, but you can change many features of the plane, including the wings, stabilizers, propulsion, and colors.

Entertainment Flight Simulator includes several games to test your skills.

System Requirements

The following equipment is required:

- IBM Personal Computer, XT, AT, Personal System/2, or compatible
- At least 384K of memory for the IBM PC with CGA. Other graphics adapters may require more memory. If so, the program will specify the requirement when you start.
- At least one floppy disk drive (double-sided, low- or high-density)
- Color Graphics Adapter (CGA), Enhanced Graphics Adapter (EGA), Video Graphics Array (VGA), Personal System/2 Graphics System, or Hercules Monochrome or InColor Card
- Appropriate monitor for your graphics adapter
- MS-DOS® (version 2.0 or later) or PC-DOS

Optional equipment:

- Hard disk drive
- Microsoft® Mouse
- One or two joysticks or a control yoke, and an IBM-compatible Game Control Adapter Card

Learning to Fly

First, follow the “Getting Started” instructions in this introduction to get the simulator running, and then learn the instruments and controls in the “Flight Simulator Basics” section.

Go through the “Flying Flight Simulator” section to get airborne. Chapter 3, “Flying the Single-Engine Aircraft,” is an orientation course for new pilots, and a check flight for those with previous flight experience. Experienced pilots may skip over the flight instruction sections (“Pre-Takeoff Check” and “Landing”).

Before flying the Learjet or sailplane, all pilots should read chapter 4, “Flying the Business Jet,” or chapter 5, “Flying the Sailplane,” to understand the control and realism differences.

If you are a new pilot, proceed to the “Flight School” section, where you’ll attend a brief ground school, followed by basic, advanced, and aerobatic flying lessons; you’ll also learn about navigation, flight analysis, and course plotting. Experienced pilots will also find flight analysis and course plotting quite useful.

When you are ready for more challenging flying and if you want more control over the simulation, turn to the “Flight Simulator Configuration and Navigation” section. Here, you learn how to use the menu system to activate everything from surface winds to turning the sound on and off. Finally, if you prefer to have some video-game-like fun, check out the “Entertainment” section.

Throughout your flights, use the appendixes in the “Reference to Flight Simulator” section. Look over these sections before going any further, just to get to know what’s there.

About This Manual

This manual includes all the instructions necessary to fly Flight Simulator. It also contains sections on basic flying techniques and flying lessons.

Terms that appear in *italic* in the text are defined in the Glossary.

The following conventions are used in this manual and will help you when learning and flying Flight Simulator. Knowing these conventions will help you learn quickly when using the simulator, and will help refresh your memory about controls and menus after long periods away from Flight Simulator.

- Menu options have symbols in them that tell you how to use the option.

Symbol	Meaning
+	This option is on. Selecting the option toggles it on and off.
...	Selecting this option causes another menu to appear.
#	The key(s) following # can be used to select the option from the keyboard. Do not press # first.
:	Selecting this option causes the item following it to cycle through a few choices.
;	Selecting this option requires you to type something, and then press Enter.

- Instruments and controls on the instrument panel have letters on them. These letters tell you which key to press to use the instrument or control.
- Selecting an option often takes you to a new menu. The Esc key moves you back to the previous menu. When in any menu, press Spacebar to start flying again and to display the menu bar.

- “Click the mouse” means to point to something on the screen with the mouse-controlled cursor and press the left mouse button. “Drag the mouse” means to point to something on the screen, hold down the left mouse button, and move the pointer to a new location.
- Pressing the right mouse button toggles between Pointer mode and Control Yoke mode.
- The plus key and minus key are used to increase and decrease the setting of many instruments. Always press the key for the instrument you want before pressing the plus key or minus key.
- A + between two keys means that you hold down the first key while you press the second key. For example, to pan up, “Shift+Backspace” means you press and hold Shift while you press Backspace.
- A comma between two keys means you press and release the first key, and then press the second. For example, to change your viewing direction, “Scroll Lock, Left Arrow” means you press and release Scroll Lock, and then press the Left Arrow key to look out the left side of the plane.

About the Designer

Flight Simulator was written by Bruce Artwick of The Bruce Artwick Organization Ltd. (BAO), which specializes in microcomputer simulation design. Artwick gained extensive experience in high-performance signal processor architecture and radar control systems at Hughes Aircraft Company and has researched microcomputer-based graphics system design at the Aviation Research Laboratory and Digital Computer Laboratories, University of Illinois, where he received a B.S. and M.S. in electrical engineering. He is the former engineering director of SubLOGIC Corporation. Artwick is an aviation enthusiast and has been a private pilot since 1975.

Flight Simulator 4.0—Changes from 3.0

Flight Simulator 4.0 includes the following improvements over version 3.0:

Experimental aircraft You can adjust many of the flight characteristics on this aircraft and create experimental planes.

Sailplane The sailplane lets you experience nonpowered flight.

Weather system In addition to fixed, programmable wind and clouds, there are now random weather variations and updrafts, which are particularly useful when you fly the sailplane.

Custom 386 modules These modules make the program run faster on a 386-based microcomputer by using 386 microprocessor-specific instructions.

Dynamic scenery Other aircraft and ground scenery appear in your airspace.

Spot mode view direction You can now change this from the keyboard.

Improved aircraft flight characteristics Improvements are especially noticeable in steep banks and in unusual flight attitudes.

Time of day and random weather startup Flight Simulator can start running at the time of day and season determined from your computer system clock, with random weather to match the time of day and season.

Approach lighting systems (ALS) The approach lighting is improved, making airports more realistic. The systems include Visual Approach Slope Indicator (VASI), Runway End Identifier Lights (REIL), runway alignment indicator lights (RAIL), which form a flashing row of strobes, and rows of approach lights (MALSR).

Air traffic control communications The air traffic control tower now clears you to land and tells you which transponder frequencies to use, making flight around airports more realistic.

IMPORTANT

If you are installing Flight Simulator on a hard disk, and want to keep version 3.0, be sure to keep the version 3.0 and 4.0 files in separate directories. Many files have the same names but are not interchangeable between versions. To avoid file mix-ups, keep Flight Simulator 3.0 in a different subdirectory from Flight Simulator 4.0.

Getting Started

The Flight Simulator program is contained on the disk or disks you received in this package. There are no hidden files or copy protection.

IMPORTANT

Flight Simulator does not support the use of desk accessories, also known as terminate and stay-resident programs, such as SideKick and Fansi-Console. Be sure to quit these applications before running Flight Simulator.

Using a Floppy Disk System

Be sure to make a working copy of the Flight Simulator disks. Always run Flight Simulator from your copies; store the master disks in a safe place. To make a working copy, copy all the files onto newly formatted floppy disks, or use the DISKCOPY program that comes with MS-DOS or PC-DOS. Your MS-DOS manual describes how to make copies of standard MS-DOS disks.

Starting Flight Simulator from Floppy Disk

- 1 Start MS-DOS or PC-DOS.
- 2 Insert the Flight Simulator Program disk into drive A.
- 3 Type **a:** and then press Enter to change to drive A.
- 4 Type **fs** and then press Enter to run Flight Simulator.

Note The 5.25-inch disk version is contained on two disks. Flight Simulator will ask for the Scenery disk when required.

Copying Flight Simulator to a 1.2-megabyte 5.25-inch Disk

If your system has a high-density disk drive, Flight Simulator can be copied to a 1.2-megabyte disk for backup or to avoid switching disks.

- 1 Insert a blank, formatted 1.2-megabyte disk into the high-density drive.
- 2 Change to that drive.
- 3 Type **md fltsim4** and then press Enter to make a directory for Flight Simulator.
- 4 Type **cd fltsim4** and then press Enter to change directories.
- 5 Insert one of the Flight Simulator disks into the second drive.
- 6 Copy all Flight Simulator files to the 1.2-megabyte disk.

For example, if drive A is the high-density drive, type **copy b:*. * a:** and then press Enter.

- 7 Repeat steps 5 and 6 for the second Flight Simulator disk.

Using a Hard Disk System

The Flight Simulator program and scenery load faster when installed on a hard disk than on a floppy disk .

Installing Flight Simulator on your Hard Disk

- 1 Start MS-DOS or PC-DOS.
- 2 Insert the Flight Simulator disk into drive A.
- 3 Change to the hard disk where you want to put Flight Simulator.
For example, to change to drive C, type **c:** and then press Enter.
- 4 Type **cd** and then press Enter to go to the root directory.
- 5 Type **md fltsim4** and then press Enter to make a directory for Flight Simulator.
- 6 Type **cd fltsim4** and then press Enter to change directories.
- 7 If you are using 5.25-inch disks, type **copy a:*. * *** and then press Enter to copy all Flight Simulator files from the disk in drive A to the hard disk.

Repeat this step for the second disk.

If you are using 3.5-inch disks, type **copy a:\fltsim4*. * *** and then press Enter to copy all Flight Simulator files from the disk in drive A to the hard disk.

Starting Flight Simulator from Hard Disk

- 1 Start MS-DOS or PC-DOS.
- 2 Change to the directory set up for Flight Simulator.
For example, to change to the directory called FLTSIM4 on the hard disk, type **cd fltsim4** and then press Enter.
- 3 Type **fs** and then press Enter to run Flight Simulator.

Answering the Startup Questions

When started, Flight Simulator asks a series of questions concerning monitor type, keyboard, and so on. This section explains each menu to help you decide on the appropriate response. Select the responses appropriate for your configuration from the menus.

Flight Simulator has “installable drivers” to accommodate newer PC display and control devices and new additions to Flight Simulator software. Menu options increase as new display- and control-system drivers are added to Flight Simulator. Any additional menu items are usually self-explanatory and are described in documentation that comes with the drivers.

Startup Sequence Selection

If Flight Simulator was previously set up, a menu appears when you start the program that allows you to select the startup sequence. You can select to go through the startup menus or use the no-questions-asked startup.

Select option 1. For information about option 2, see “No-Questions-Asked Startup” later in this introduction.

Custom Machine Drivers

If your computer has an 80386 processor, you can select custom drivers for the 80386 that are faster than the standard Flight Simulator drivers. Select the option that represents the type of computer you have—either 8086 or 8088 driver, 80286 driver, or 80386 driver.

Display Device Selection

This menu asks you to select your display device. You must know what display device (graphics adapter and monitor) you are using. The most common adapter is the Color Graphics Adapter (CGA). If you are not sure, select option A or B first.

Some graphics adapters have more than one mode. The Enhanced Graphics Adapter (EGA), for example, has color and monochrome modes. The mode you select depends on the monitor you are using. Read the menu items and find the one that most closely matches your adapter and monitor.

- If you are using a PS/2 (Models 25 and 30), select display option J, IBM PS/2 256 Color 320x200.
- If you are using a gas plasma monitor, select display option B, Black And White Monitor (CGA).
- If you are using an LCD display, select display option D, Liquid Crystal Display (CGA).
- If you are using an EGA graphics card, the minimum EGA card memory requirement is 256K.
- If your system contains a Hercules-compatible graphic board and a CGA-compatible board, the Hercules display option may function improperly. If you have this problem on your system and you want to run in the Hercules mode, you must remove the CGA board. If you are running in CGA mode, you should have no problem.

Operating Mode Menu

Using this menu, you can select either a normal flight mode or select the Flight Simulator demo.

There are two normal flight modes. Both start on Meigs Field in Chicago: option A starts during the day; option B uses your computer system time and date to determine the time of day and season.

There are two demo modes, one with sound and one without sound.

If you select a demo mode from the startup screen, with or without sound, your mouse won't work. If you want to use the mouse after the demo finishes, you should start Flight Simulator by selecting option A, Normal Flight Mode, and then run the demo from within the program. To select the demo from within the program, select option 6, Demo, on the Mode menu.

To exit from demo mode, press Esc; all other keys are locked during a demo.

Environment Conditions

On this menu, you specify the environmental conditions that you want when Flight Simulator starts. Select dynamic scenery, random weather, both, or neither. For the fastest display rate, select option D, Neither.

Keyboard Type Selection

There are a few variations of PC keyboards. Use this menu to specify where the function keys, F1 to F10 or F12, are on your keyboard: left side or across the top; or to specify that you are using a Tandy 1000 keyboard.

If you are using a laptop computer, some keyboard functions may not be available, although all functions are available through menus. By pressing the NumLock key, some alphanumeric keys assume the layout of the 10-key numeric keypad, and operate view selection and airplane controls. In “standard” keyboard mode, the keys correspond to the alphabetic assignments (such as pause or strobe on and off). Pressing NumLock turns on the map view, and activates the keypad mode. If you press NumLock twice rapidly, you turn off the map while retaining the keypad mode.

Logbook Updating

Flight Simulator can keep a logbook of all your flights. This menu asks if you want to log this flight. If you press Y for yes and can create the logbook, Flight Simulator asks for the name of the logbook in which you want the flight logged.

Type the name (an abbreviated form of your name is appropriate). If the logbook doesn't exist, Flight Simulator asks if you want to retype the name, create a logbook with that name, or cancel the request to log the flight. Select the appropriate option.

For more information about logbooks, see chapter 11, “Logbook.”

Mouse Selection

If your machine has a mouse driver installed, you can use the mouse with Flight Simulator. The mouse can be used to fly or to select menu options. Press Y if you want to use the mouse; press N if you don't.

Joystick Selection

If your machine has joysticks installed, you can use them with Flight Simulator. Press Y if you want to use joysticks; press N if you don't.

If you answer yes, you next select the joystick configuration, and then calibrate the joysticks. Flight Simulator includes menus to step you through the configuration and calibration. Joysticks should be placed in the calibration position, with stick A centered in both the X and Y axes and stick B centered in the X axis and all the way back in the Y axis. Press any key to continue. For more information, see appendix D, “Using a Mouse and Joysticks.”

No-Questions-Asked Startup

If you always answer the startup questions in the same way, you can use the no-questions-asked startup feature so Flight Simulator automatically answers the questions.

When you start Flight Simulator and answer the startup questions, Flight Simulator creates a file called AUTOEXEC.FS4 containing your responses. If you are running Flight Simulator from a floppy disk, be sure the program disk is not write-protected. Make a backup copy of the program disk and run it without the write-protect tab. Never remove write protection from the master disk.

Using No-Questions-Asked Startup

- ▶ Type **fs4** and then press Enter. Your previous responses are used to answer the questions.

When you type **fs** to start, and Flight Simulator finds AUTOEXEC.FS4, the Select Startup Sequence menu appears asking if you want to go through the menus or perform the no-questions-asked startup. If you ever want to change your answers to the menu questions, go through the menus. The new startup sequence will be recorded. If you don't want this menu to appear, either delete AUTOEXEC.FS4 or rename it.

Exiting Flight Simulator

To exit Flight Simulator and return to MS-DOS or PC-DOS, press Ctrl+C or Ctrl+Break. You can also select option 7, Quit, on the Mode menu.

Flying Start

If you're eager for your first flight—even before you read this manual—you can start flying now by following this procedure. You'll get an idea of what Flight Simulator is all about.

Making your First Flight

- 1 Start Flight Simulator.
- 2 If you see the menu telling you to select the startup sequence, select option 1, Go Through Startup Menus.
- 3 When the startup menus appear, select the processor type and display device that most closely match your system.
- 4 Select option A, Normal Flight Mode, for the operating mode.

- 5 Select option D, Neither, on the Dynamic Conditions menu.
- 6 Select the keyboard type by seeing if the function keys are on the left or top of the keyboard. Press A if on the left; B if on top; C if a Tandy 1000 keyboard.
- 7 Press N when asked if you want to log the flight, use the mouse, and use joysticks.
- 8 After you answer the questions, you'll be on Meigs Field in Chicago (a small airport on a peninsula projecting into Lake Michigan).
- 9 Press Scroll Lock, Left Arrow key to look out of the left side of the airplane. Notice the wing at the top of the three-dimensional display.
- 10 Press Scroll Lock, Down Arrow key to look out of the back of the plane. Notice the tail at the center of the screen.
- 11 Press Scroll Lock, Up Arrow key to return to a forward view.
- 12 If the function keys are on the left of the keyboard, press F2; if the function keys are across the top, press F4. This increases throttle to full so the plane starts rolling down the runway. The plane will take off by itself. You'll be able to tell when you leave the ground.
- 13 Once airborne, press Scroll Lock, Down Arrow key to look out the back again.
- 14 Press Scroll Lock, Up Arrow key for the front view. Watch the flight instruments. Airspeed, altimeter, and vertical velocity gauges each show movement.
- 15 Press the Left Arrow key to start banking the plane. The horizon will tilt. Don't let the bank get too steep.
- 16 After about 20 degrees of bank, press 5 in the center of the numeric keypad (not on the top row of keys) to neutralize the ailerons and rudder and keep the plane in its current bank.
- 17 Now press the Up Arrow key six times (the plane will begin a dive), and wait about a minute without touching the controls.
- 18 After crashing, Flight Simulator resets and returns you to your starting location.

For More Information on Flying

If you would like further information on flying, you can read any of the following publications. They are available at *Fixed Base Operators (FBOs)* or flight training schools at most airports.

To learn about flying:

- *Flight Training Handbook*, U.S. Department of Transportation, Federal Aviation Administration
- *Aviation Fundamentals*, Jeppesen Sanderson, Inc.
- *Instrument Flying Handbook*, U.S. Department of Transportation, Federal Aviation Administration
- *Flight Physics and Aircraft Control with an Introduction to Aerobatics*, Momet and Emanuel

To learn about aerodynamics:

- *Aerodynamics for Naval Aviators*, Superintendent of Documents, U.S. Government Printing Office
- *The Illustrated Guide to Aerodynamics*, Smith
- *The Advanced Pilot's Flight Manual*, William Kershner, Iowa State University Press

To learn about sailplanes and soaring:

- *Soaring Society of America Soaring Flight Manual*, PO Box E, Hobbs, New Mexico 88241
- *Schweizer Soaring School Manual*, Schweizer Aircraft Corp., PO Box 147, Elmira, New York 14902

Other publications:

- *Airman's Information Manual*, Aero Publishers, Inc.
- *Chicago Sectional Aeronautical Chart*
- *Los Angeles Sectional Aeronautical Chart*
- *New York Sectional Aeronautical Chart*
- *San Francisco Sectional Aeronautical Chart*
- *Seattle Sectional Aeronautical Chart*

Many of these publications can also be ordered directly from Sporty's Pilot Shop, Clermont County Airport, Batavia, Ohio 45103, 1-800-543-8633.

Flight Simulator Basics

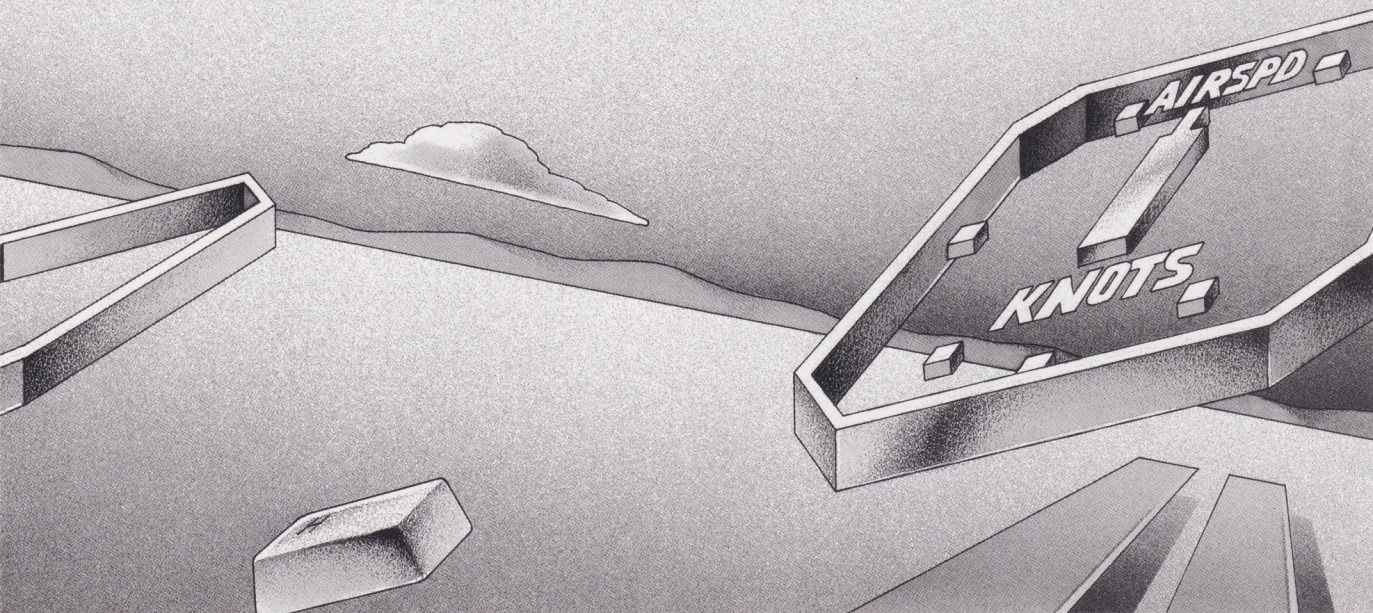
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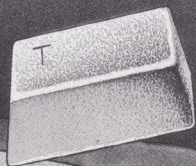
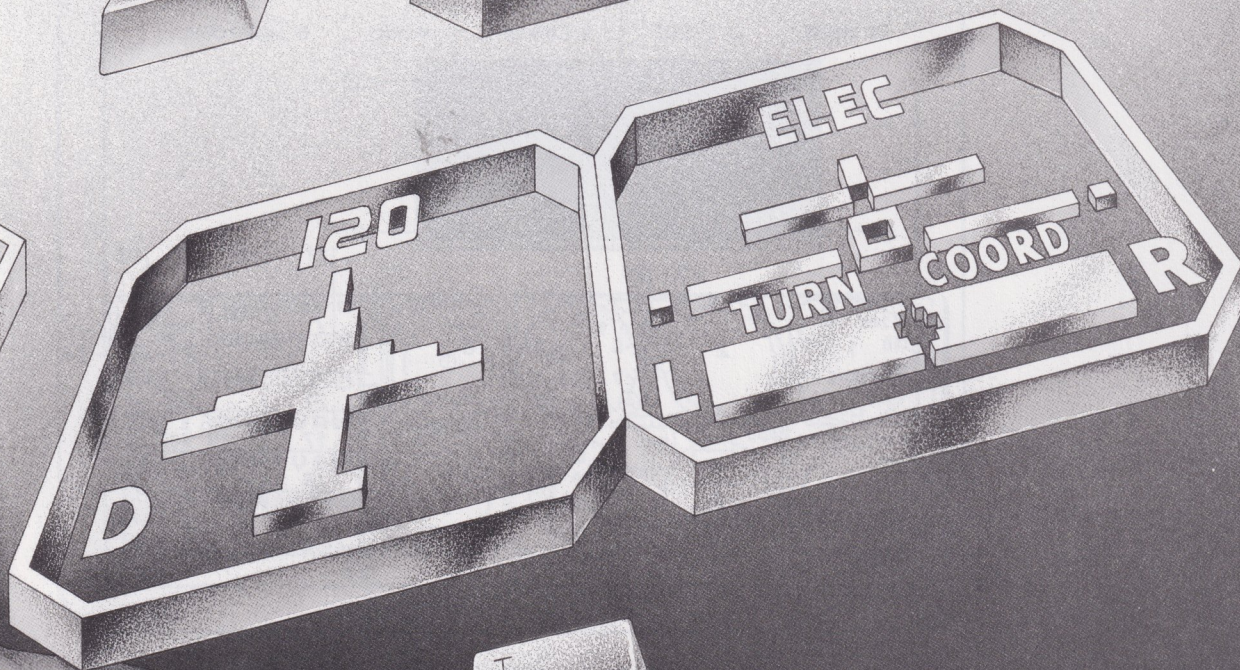
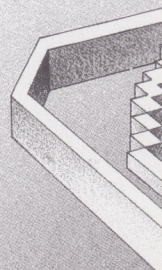
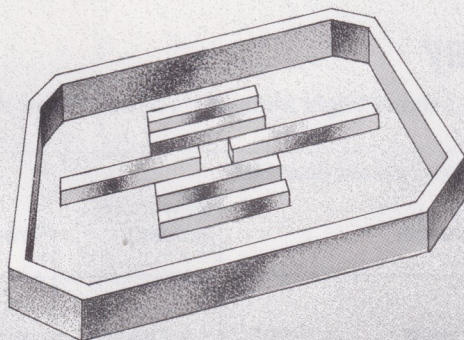
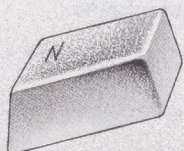
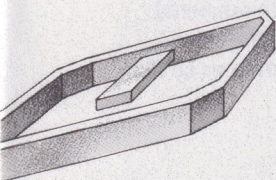
Flight Simulator Basics

This section covers the basics that you should learn before flying Flight Simulator. Read the following chapters to learn about aircraft controls, instruments, and flight systems.

Chapter 1, "Basic Window Display and Flight Instruments," describes what you see on the screen. The three-dimensional window view, flight instruments, and radios are explained.

Chapter 2, "Aircraft Controls," tells how to control the aircraft, set the radios, and calibrate flight instruments using the keyboard and, optionally, a mouse and joystick.





1: Basic Window Display and Flight Instruments

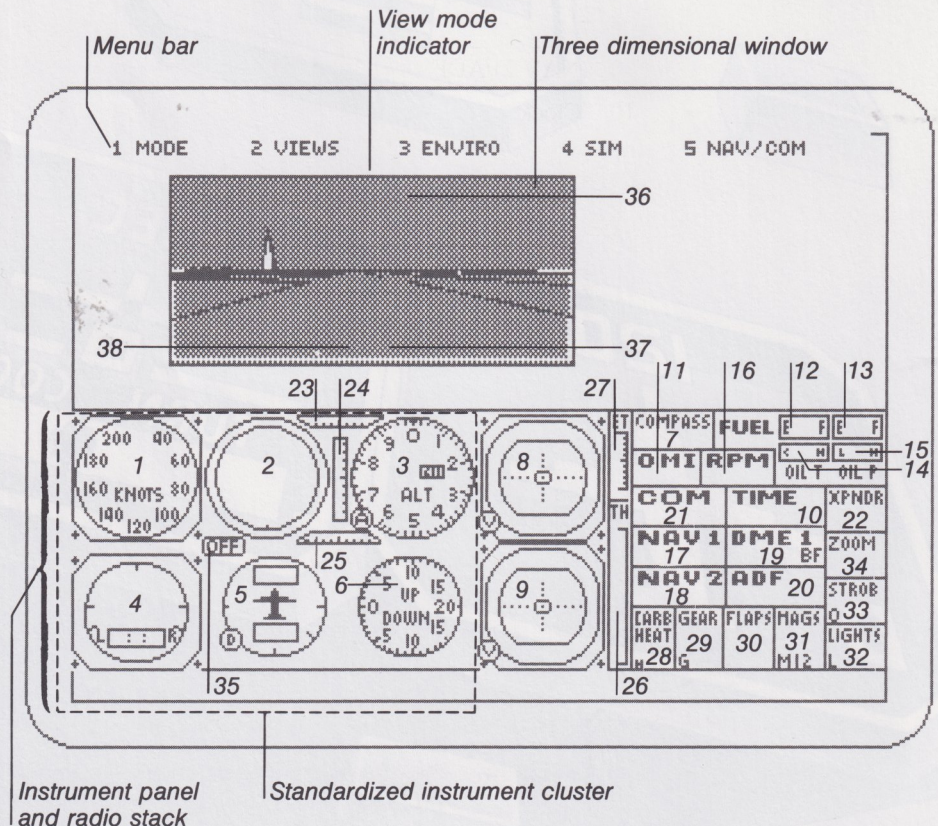
Flight Simulator has all the instruments and equipment required under *FAA* regulations (part 91.33) for day and night *Visual Flight Rules (VFR)* and day and night *Instrument Flight Rules (IFR)* under non-icing conditions.

Flight Simulator follows a “window” philosophy that places three-dimensional views, the control panel, and command menus in their own areas on the screen. This section describes the instruments, radios, and 3-D and other windows so that you will recognize them when they appear.

Basic Window Display

Figure 1.1 shows Flight Simulator’s basic window display.

1.1 Instrument Panel and Radio Stack



Instrument Panel and Radio Stack

Standardized Instrument Cluster

1. Airspeed Indicator (knots)
2. Attitude Indicator or Artificial Horizon
3. Altimeter (feet)
4. Turn Coordinator
5. Heading Indicator or Directional Gyro
6. Vertical Speed or Rate of Climb Indicator

Other Flight Instruments and Indicators

7. Magnetic Compass
8. Omni-Bearing Indicator (OBI) with Glideslope (NAV 1)
9. Omni-Bearing Indicator (NAV 2)/ADF
10. Clock
11. O (Outer), M (Middle), and I (Inner) Marker Lights
12. Left Wing Fuel Tank Gauge
13. Right Wing Fuel Tank Gauge
14. Oil Temperature Gauge
15. Oil Pressure Gauge
16. Tachometer

Radios

17. NAV 1 Radio
18. NAV 2 Radio

Radios (continued)

19. Distance Measuring Equipment (DME)
20. Automatic Direction Finder (ADF)
21. COM Radio
22. Transponder

Control Position Indicators

23. Aileron Position Indicator
24. Elevator Position Indicator
25. Rudder Position Indicator
26. Throttle Position Indicator
27. Elevator Trim Indicator

Indicator Boxes on the Control Panel

28. Carburetor Heat Indicator
29. Gear Indicator
30. Flap Position Indicator
31. Magnetos Indicator
32. Lights Indicator
33. Strobe Indicator
34. Zoom Indicator
35. Autopilot Status Indicator

Heads Up Display Indicators

36. Axis Indicator
37. Stall and General Warning Indicator
38. Brakes Applied and Status Indicator

This is the basic display configuration using a Color Graphics Adapter (CGA) on an IBM PC. Different display systems (EGA, VGA, Hercules, Personal System/2) result in similar displays with higher resolution and more colors.

Screen Color Schemes and Patterns

Flight Simulator takes advantage of your display driver's features. Three-dimensional views, the instrument panel, and map view are presented in color if

your display device has that capability. Dithering (creating shades of gray and distinctive textures using repetitive patterns) is used on monochrome displays.

Many menus and information displays need a higher resolution than low-resolution color-display modes allow. On display devices that have high-resolution color modes, all menus appear in full color. On devices without high-resolution color, the display changes to black-and-white high-resolution display mode for some menus. Loss of color is normal on 3-D windows and the instrument panel while these menus are active.

Menu Bar and Menu System

The menu bar at the top of the screen contains the menus you use to control the simulation (see figure 1.1). Each menu contains several options.

Choose	To
1 Mode	Select among demo and flight modes; select aircraft type; save and recall situations; record and play back instant replays and demos.
2 Views	Select among Cockpit, Tower, Track, and Spot modes; set up windows and window characteristics.
3 Enviro	Alter environmental factors such as season, time, clouds, and winds.
4 Sim	Adjust simulation factors internal to the aircraft and simulation system, including reliability, sound, pause, and auto-coordination; set up and calibrate mouse and joystick.
5 Nav/Com	Adjust navigational factors, including map display, autopilot, and your location in the world; set up communication functions, including air traffic control communication.

Each menu has a number before it which you use to select the menu.

Selecting a Menu with the Keys

- Press the number on the keyboard, not the keypad.

Selecting a Menu with the Mouse

- 1 If you are in Control Yoke mode instead of Pointer mode, click the right mouse button to change modes.
A pointer on the screen indicates that you are in Pointer mode.
- 2 Point to the menu name.
- 3 Click the left mouse button.

After a menu is selected, a list of options is displayed below the selected menu name. Select options from these menus in the same way, by pressing or clicking the number or letter in front of the option. When an option is preceded by a letter instead of a number, pressing the letter key selects the option instead of performing a function. For example, on the Mode menu, the Plane option is preceded by an A. When the Mode menu is displayed, pressing A cycles through the planes instead of adjusting the altimeter.

Menu Option Standard Conventions

Menu options follow standard conventions shown by these examples:

- | | |
|-----------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1 + Map | The plus means that this option is selected. If you select an option with a plus, the option is turned off. If you select it again, it is turned back on. |
| 2 Clouds... | The three dots after the option mean that selecting this option causes another menu to be displayed. |
| 3 Sound #Q | The #Q after the option indicates that you can select the same option without selecting the menu by pressing the Q key on the keyboard. Options that have a key associated with them are more easily selected using the keyboard, but the menu option makes a good reference if you haven't flown for a while and don't remember which key to press. |
| 4 Window: First 3D | A colon means that selecting this option cycles through the options following the colon. In this example, the sequence is First 3D, Second 3D, and Map. |
| 5 Speed; 25 | A semicolon means that after selecting the option, you must type something, and then press Enter. In this example, after selecting option 5, you type a wind speed, and then press Enter. |

Activating the Menu System

The menu system is active when the menu bar appears at the top of the screen. If the menu bar is not visible, you can activate it.

- ▶ To activate the menu bar, press Esc.

Removing Menus

As you select options that generate new menus, you may have many overlapping menus on the screen. You can remove the menus one at a time, or you can remove all menus at once.

- ▶ To remove one menu at a time, press Esc.

With the mouse in Pointer mode, you can point to the next-to-last option on the menu, Exit This Menu, and click the left mouse button.

- To remove all menus, press Spacebar.

With the mouse in Pointer mode, you can point to the last option on the menu, Return To Simulator, and click the left mouse button.

Exiting the Menu System

- To remove the menu bar, press Esc.

Three-Dimensional Window

A three-dimensional window usually occupies the top half of the screen (see figure 1.1). Depending on what you select, it can be the view through your windshield, the view from a spotter plane, or the view from the control tower. Through this window you can see the runway, terrain, and horizon.

The visual effects of the Flight Simulator program are realistic. Solidly shaded surfaces give the feeling of depth and substance. Cloudy days bring dark skies until you break out of the clouds and reach clear sky. As you fly through the clouds, visibility is obscured. At night, lights on the ground are your only visual reference.

Instrument Panel and Radio Stack

The instrument panel and *radio stack* window occupies the lower half of the screen. Move this window down by dragging the top of the panel with the mouse, or by selecting Setup Windows from the Views menu. This makes room for a larger three-dimensional window or map window. For more information, see “Sizing and Moving a Window” in chapter 2, “Aircraft Controls.”

Instruments on the panel and radios in the stack are arranged as they would be in most aircraft. Styles vary from plane to plane, but Flight Simulator uses the most up-to-date instruments.

The six primary flight instruments are grouped together in the *standardized instrument cluster* (see figure 1.1). In addition, the instrument panel includes other instruments, indicators, and radios. You use only a few of these on your first flight. The instruments are described in more detail in chapter 2, “Aircraft Controls.”

The numbers accompanying the instrument and radio names and descriptions in the following section correspond to the numbers in figure 1.1.

Standardized Instrument Cluster

1. Airspeed Indicator Measures in *knots* the aircraft's speed through the air. The *airspeed indicator* is an air-pressure-activated gauge. It does not measure ground speed.

2. Attitude Indicator or Artificial Horizon Shows the aircraft's pitch and bank attitudes. *Pitch* is the *rotation* of the plane about its *lateral axis* (nose up or nose down). When the center bar of the attitude indicator is aligned with the horizon, you are flying in straight and level flight. Horizontal markings near the center indicate nose-up and nose-down pitch angles.

Bank is the *rolling* of a plane on its *longitudinal axis*. The bank indicator has a small arrow that points to the 10-, 20-, 30-, 60-, or 90-degree marking at the edge of the attitude indicator. When the arrow points to the 0-degree bank mark, you are in straight and level flight. The arrow always points to the top of the gauge. The bank marks rotate around the edge of the instrument.

3. Altimeter Measures altitude in feet above mean sea level (MSL). The gauge is operated by *atmospheric pressure*. The *altimeter* is read like a clock, with 10 divisions instead of 12. The large hand indicates hundreds of feet above sea level (in 20-foot increments), and the small hand indicates thousands of feet above sea level. The small arrow near the outside of the gauge indicates tens of thousands of feet above sea level.

Sea level is not the same as ground level. For example, at an airport with a 750-foot elevation, the altimeter registers 750 feet while the plane is sitting on the ground.

Barometric pressure changes caused by changes in the weather can cause errors in altitude readings. Pilots must often calibrate the altimeter to the barometric pressure of the *airspace* through which they are flying. U.S. pilots calibrate to current air pressure at sea level in inches of mercury; European flyers calibrate to pressure in millibars. At an altitude above 17,999 feet, you must calibrate to *standard pressure*—29.92 inches of mercury, or 1013 millibars.

The knob marked with an "A" is the altimeter adjustment knob. To adjust barometric pressure to the correct value, press the A key; with a mouse, point to the knob and click the left mouse button. Barometric pressure is indicated in the small square barometric pressure window. On Flight Simulator, this window is too small to plot the digits, so the window has fixed digits.

4. Turn Coordinator Measures turn rate and coordination. No numerical value appears on this gauge. Instead, a single turn rate position is marked by the turn indicator (the small airplane symbol on the gauge). When the gauge aligns with the "L" (Left) or "R" (Right) indicator, you make a two-minute turn. This means that the plane will complete a 360-degree turn in two minutes. The turn coordinator, unlike the turn indicator gauge used in some planes, uses a 35-degree *canted gyroscope* that reflects both bank and *heading* changes. Pitch, however, has no effect on the gauge. The turn indicator is also useful for timed turns.

The ball in the turn coordinator indicates *slip/skid* attitude, or aircraft coordination. When the ball is centered, the aircraft's longitudinal axis is parallel to the direction of flight and the flight is *coordinated*. Coordinated turns are the safest turns. Some maneuvers, notably slips and skids, are not coordinated.

5. Heading Indicator or Directional Gyro Notes the direction of flight. The *heading indicator* is a gyroscopically controlled compass that, unlike a *magnetic* compass, has no inherent direction-seeking characteristics. It is much more responsive and steady than the magnetic compass. Using the magnetic compass, calibrate the heading indicator before each flight and a few times an hour while in flight.

The knob marked with a “D” is the heading indicator adjustment knob. To set the heading indicator, press the D key; with a mouse, point to the knob and click the left mouse button. Always be sure that the magnetic compass has stabilized after a turn or climb-to-level transition to avoid setting a wrong heading.

6. Vertical Speed or Rate of Climb Indicator Measures *rate of climb* or descent in hundreds of feet per minute. This gauge operates on air pressure changes and is not adversely affected by absolute barometric pressure. It lags slightly behind the aircraft’s responses; avoid “chasing” (flying in direct response to) the vertical speed indicator to establish a constant altitude.

Other Flight Instruments and Indicators

7. Magnetic Compass A standard magnetic compass.

8. Omni-Bearing Indicator (OBI) with Glideslope (NAV 1) A landing approach and general navigation instrument that is used with the NAV 1 (Navigation) radio to tune into VOR (Very high frequency Omnidirectional Range) radio beacons.

9. Omni-Bearing Indicator (NAV 2)/ADF Same as above, but used with the NAV 2 radio. A *glideslope* is not available on this OBI. ADF can also occupy this position.

10. Clock A standard digital clock that runs in real time and measures hours, minutes, and seconds. Under 1982 FAA regulations, a digital presentation qualifies for IFR flight in lieu of an analog sweep second-hand clock. The Flight Simulator clock is very accurate. You set the clock by selecting option A, Time Set, on the Enviro menu or by clicking the digits with the mouse.

11. O (Outer), M (Middle), and I (Inner) Marker Lights Lights that indicate when your aircraft is over the outer, middle, or inner marker beacons during an instrument approach using the Instrument Landing System (ILS).

12. Left Wing Fuel Tank Gauge

13. Right Wing Fuel Tank Gauge

14. Oil Temperature Gauge

15. Oil Pressure Gauge

16. Tachometer

Radios

17. NAV 1 Radio Used to tune in and identify VOR navigation aids. It also receives ILS (Instrument Landing System) frequencies.

The NAV radios receive 200 channels, at frequencies between 108.00 and 117.95 MHz, with 50 kHz separations. VORs are radio stations that transmit an omnidirectional synchronization signal. This synchronization signal is followed by a circular sweeping directional signal. The NAV receiver in your aircraft decodes these signals to determine the angle or radial you are on. Radials are directional beams that radiate from the VOR station. The NAV receiver also controls the *Omni-Bearing Indicator* (items 8 and 9), which you can use to guide your plane along a radial as you move toward or away from a VOR station.

18. NAV 2 Radio Same as the the NAV 1 radio. Two VOR stations can be tuned simultaneously so you can crosscheck your position.

19. Distance Measuring Equipment (DME) Works with the NAV 1 and 2 radios to tell you how many nautical miles you are from a tuned-in VOR.

20. Automatic Direction Finder (ADF) General navigation instrument used with nondirectional radio beacons (NDBs) or commercial AM radio stations to determine relative bearing. Magnetic bearing to the NDB can be calculated by adding the relative bearing to the aircraft's magnetic heading.

21. COM Radio Transceiver that receives and transmits 360 channels at frequencies between 118.00 and 135.95 MHz, with 50 kHz separations. Airport, weather, and approach information can be received by tuning in *ATIS* (Automatic Terminal Information Service) at many airports.

22. Transponder Radio used to identify your aircraft on *ATC* (Air Traffic Control) radar.

Control Position Indicators

23. Aileron Position Indicator Indicates the position of the ailerons. The ailerons are *airfoils*, located on the trailing edge of the wing, that control the movement of the plane on its longitudinal axis. When the arrow on the indicator is aligned with the center mark, the ailerons are centered. When the arrow points to the right of the center mark, right aileron is applied, causing the plane to bank right; when the arrow points to the left, left aileron is applied, causing the plane to bank left.

24. Elevator Position Indicator Indicates the position of the elevators. Elevators are airfoils that control the movement of the plane on its lateral axis, pitching the plane (nose) up and down. When the indicator arrow is aligned with the center mark, the elevators are centered. When the indicator arrow is above the center mark, the elevators are raised; when below, the elevators are lowered.

25. Rudder Position Indicator Indicates the position of the *rudder*. The rudder controls the rotation of the plane about its vertical axis (left or right rotation). When the arrow points to the right of the center mark, right rudder is applied; when the arrow points to the left, left rudder is applied. In *Auto-coordinated Flight* mode, the aileron and rudder position indicators work as a unit.

26. Throttle Position Indicator Indicates how much throttle is applied.

27. Elevator Trim Indicator Indicates elevator *trim* setting.

Indicator Boxes on the Control Panel

28. Carburetor Heat Indicator Indicates whether the carburetor heat is on or off.

29. Gear Indicator Indicates whether the *landing gear* is lowered or raised.

30. Flap Position Indicator Shows the position of the *flaps*.

31. Magnetos Indicator Indicates whether the left and right *magnetos* (engine ignition coils) are on or off. The magnetos can be switched on individually (left or right) or simultaneously (both). The magnetos indicator also acts as a carburetor mixture lean indicator for engine shutdown.

32. Lights Indicator Indicates whether the *running lights* and instrument lights are on or off. Lights should be on at night so the plane is visible to air traffic and ground observers, and so that you can see the instrument panel.

33. Strobe Indicator Indicates whether the white flashing strobes are on or off.

34. Zoom Indicator Indicates the zoom factor of the selected window. The selected window is bordered in white.

35. Autopilot Status Indicator Indicates whether the autopilot is on or off.

Heads Up Display Indicators

The following indicators appear in the 3-D window and can be switched off for a clear 3-D view, or turned on momentarily when an extraordinary event occurs.

36. Axis Indicator V-shaped bar that shows the current axis of the aircraft. This bar gives a good indication of where the aircraft's center is pointing, especially when in unusual attitudes. Note that this is not necessarily the direction the aircraft is flying. The axis indicator shape can be changed or turned off by selecting option 5, Axis Indicator, on the Views menu.

37. Stall and General Warning Indicator This indicator and an audible warning come on when the aircraft is less than five knots above stall speed (the speed at which the aircraft stops flying). Other messages are displayed here that indicate emergency conditions, such as the Gear Up warning.

38. Brakes Applied and Status Indicator This indicator tells you that brakes are applied. Messages concerning current program status, including Demo and Pause, also are displayed here.

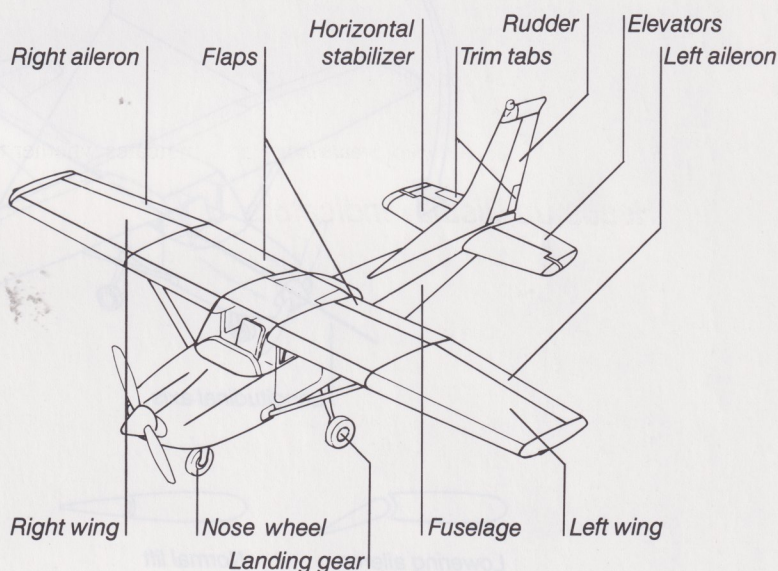
2: Aircraft Controls

Flight Simulator, like a real aircraft, has many controls: engine function controls, flight controls, and navigation and communication radios. All these controls are necessary for safe, efficient flight, but only the primary flight controls are needed to get you flying.

The first step in getting Flight Simulator off the ground is learning the keyboard and, optionally, the mouse and joystick interactions involved in flying. The next step is becoming proficient in using the primary flight controls. The view controls and secondary controls can be learned later.

Look at figure 2.1 as you read this chapter. It will help you identify the parts of the airplane as the controls are described.

2.1 Basic Aircraft Components



Note A keyboard is all that's needed to control Flight Simulator. A mouse and/or one or two joysticks can also be used to increase realism. For installation and setup information, see appendix D, "Using a Mouse and Joysticks."

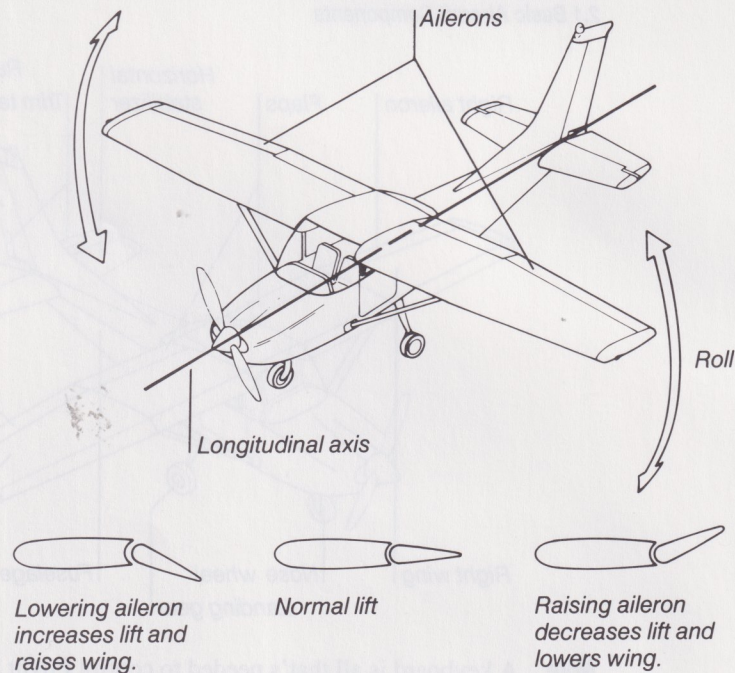
Primary Flight Controls

The primary flight controls include the *control yoke* (a steering-wheel-like control on most planes, a control stick on others), the rudder pedals, the throttle, and brakes.

Control Yoke and Rudder

The control yoke operates the ailerons and elevators, which guide the plane on its course. The ailerons, on the trailing edges of the wings, control the rotation of the plane about its longitudinal axis. Ailerons control bank, or roll, of a plane (see figure 2.2).

2.2 Ailerons

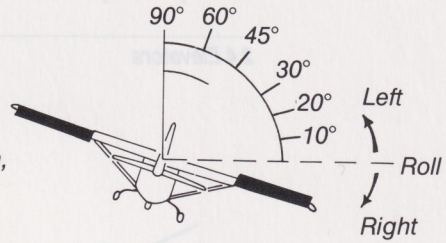


The ailerons can be controlled using the keyboard, mouse, or joystick. Figure 2.3 shows the actions required to move the controls, and describes the corresponding flight actions.

2.3 Aileron Controls and Effects

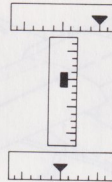
Attitude
(rear view)

Left aileron down,
right aileron up,
right roll

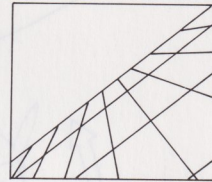


Views

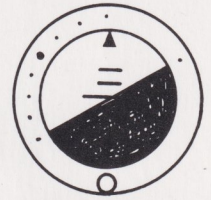
Ailerons



Position
indicator



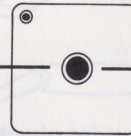
3-D view



Attitude
indicator

Joystick A

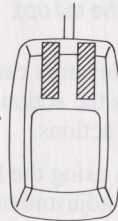
Left
bank



Right
bank

Mouse

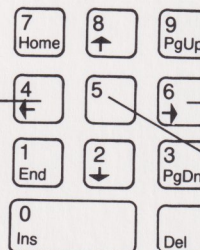
Left
bank



Right
bank

Keyboard
(Keypad control)

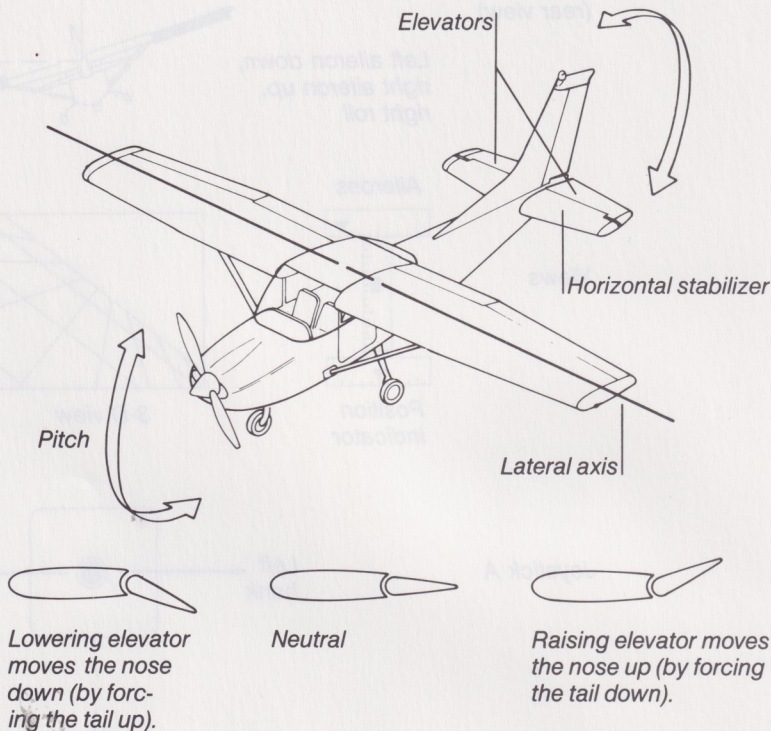
Left



Center
aileron

The elevators, on the trailing edge of the *horizontal stabilizer* (the “rear wings”), control the movement of the plane about its lateral axis (pitch), moving the nose of the plane up or down (see figure 2.4).

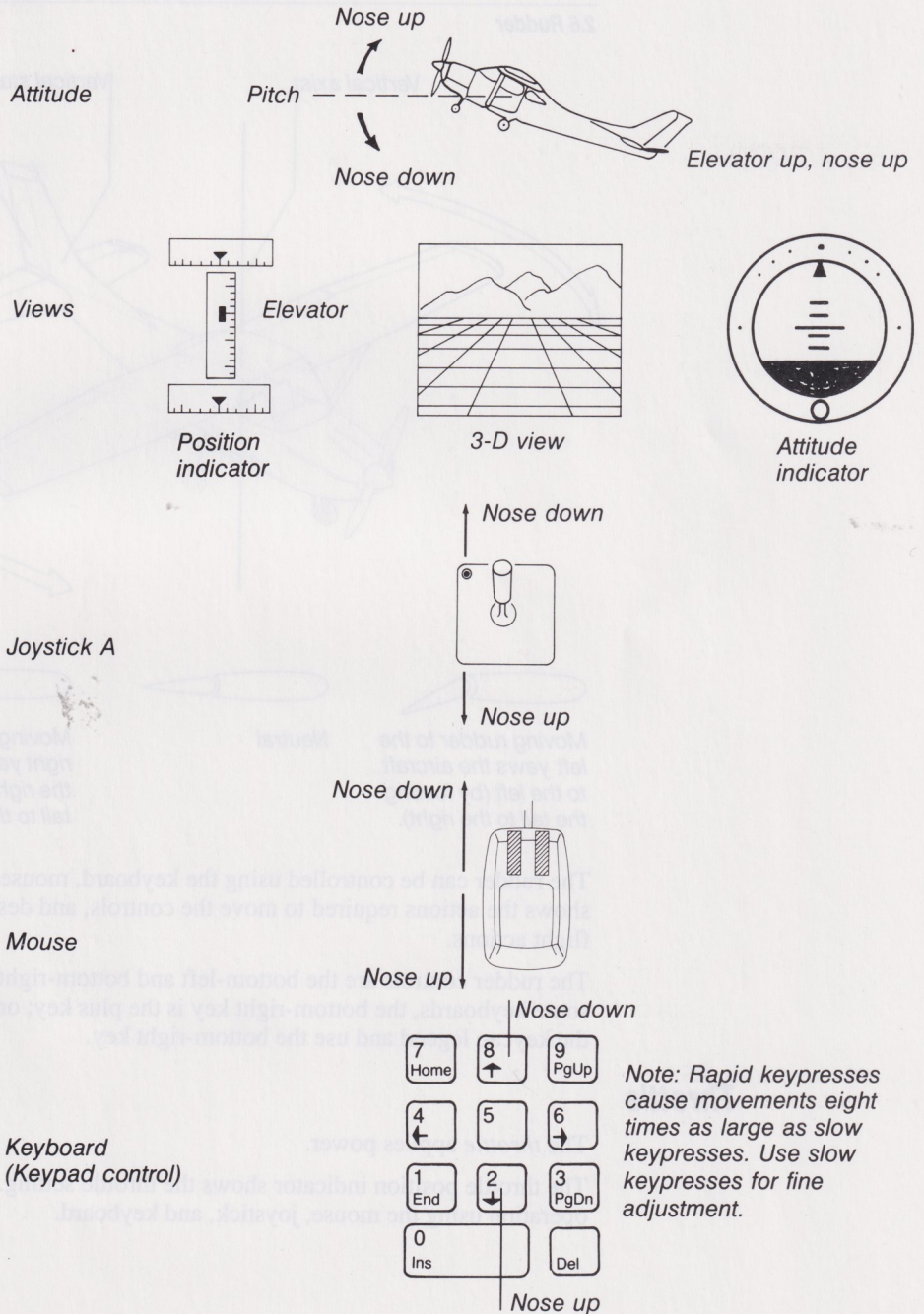
2.4 Elevators



The elevators can be controlled using the keyboard, mouse, or joystick. Figure 2.5 shows the actions required to move the controls, and describes the corresponding flight actions.

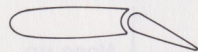
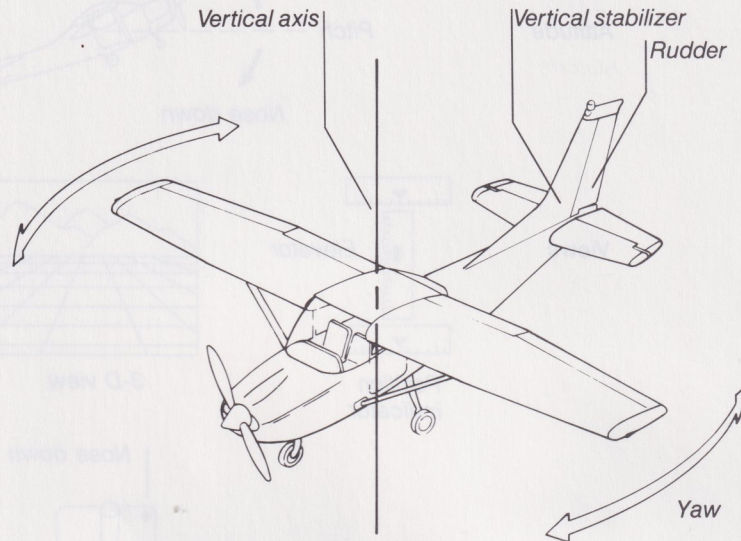
When using the keyboard, rapid keypresses of the elevator keys make broad, quick adjustments in elevator position. Pressing the elevator keys slowly, with at least one-quarter second between each press, moves the elevators by one-eighth of their normal adjustment.

2.5 Elevator Control and Effects

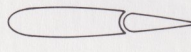


The rudder, which is located on the *vertical stabilizer* of the plane, controls the movement of the plane about its vertical axis (yaw) (see figure 2.6).

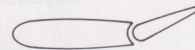
2.6 Rudder



Moving rudder to the left yaws the aircraft to the left (by forcing the tail to the right).



Neutral



Moving rudder to the right yaws the aircraft to the right (by forcing the tail to the left).

The rudder can be controlled using the keyboard, mouse, or joystick. Figure 2.7 shows the actions required to move the controls, and describes the corresponding flight actions.

The rudder controls are the bottom-left and bottom-right keys on the keypad. On some keyboards, the bottom-right key is the plus key; on others, it is Enter. Ignore the keypad legend and use the bottom-right key.

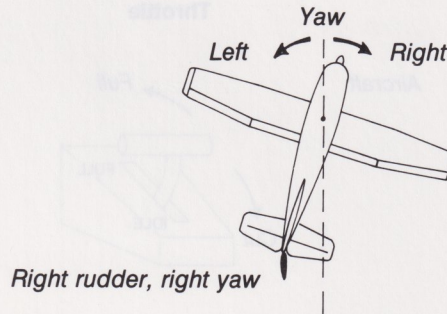
Throttle

The *throttle* applies power.

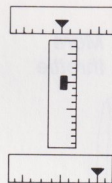
The throttle position indicator shows the throttle setting. Figure 2.8 shows throttle operation using the mouse, joystick, and keyboard.

2.7 Rudder Controls and Effects

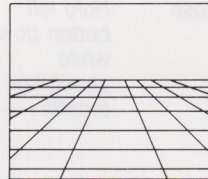
Attitude



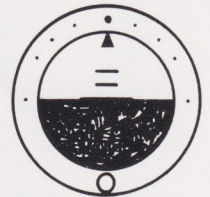
Views



Rudder position indicator

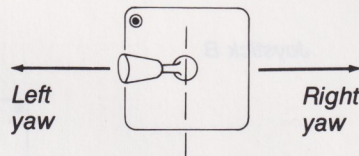


3-D view

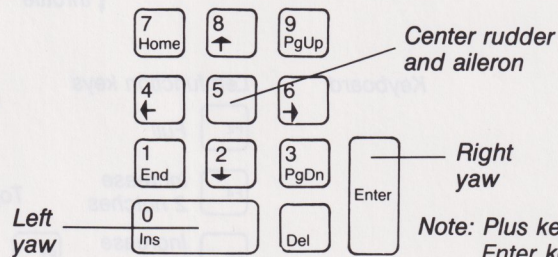


Attitude indicator

Joystick B
(alternate)



Keyboard
(keypad control)

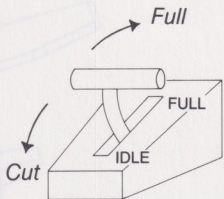


Note: Plus key on IBM PC
Enter key on PS/2

2.8 Throttle and Brake Controls

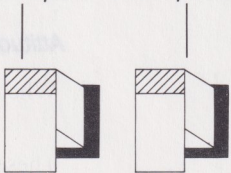
Throttle

Aircraft



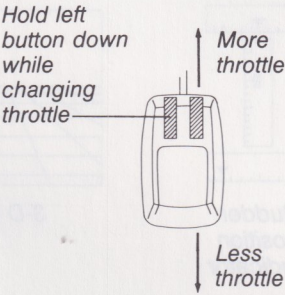
Brakes

(Press tips of rudder pedals)

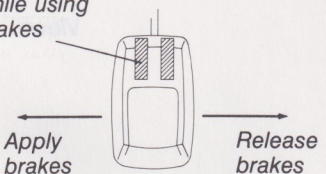


Rudder pedals

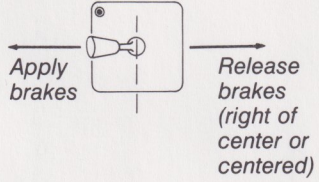
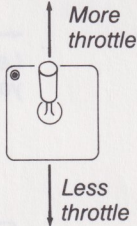
Mouse



Hold left button down while using brakes



Joystick B



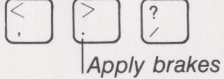
Keyboard

Left function keys

- F2 Full
- F4 Increase 2 notches
- F6 Increase 1 notch
- F8 Decrease
- F10 Cut

Top function keys

- F1 Cut
- F2 Less
- F3 More
- F4 Full



Brakes

The brakes slow the aircraft while it is on the ground. Figure 2.8 shows how to apply the brakes. To slow the plane, repeatedly press the period (.) key on the bottom row of the main keyboard. Each keypress reduces speed by a few knots. When applying the brakes using the period key, there is no need to release the brakes because they never stay on for more than a few seconds after each keypress.

When the brakes are applied, a brakes indicator appears in the bottom-left corner of the three-dimensional window.

These are wheel brakes only and have no effect in the air. Brakes are automatically released while in the air to avoid landing with them on.

View Controls

Flight Simulator has a sophisticated viewing system that gives you views from the aircraft as well as views of your aircraft as you fly. You control your views and your windows with the keyboard and the Views menu. The following table shows the commands on the Views menu:

Choose	To
1 Window	Identify and change active window: First 3D, Second 3D, Map.
2 From	Specify view mode: Cockpit, Tower, Track, or Spot.
3 Zoom	Zoom in or out active window.
4 Direc	Control viewing direction in Cockpit mode.
5 Axis Indicator	Select the shape of the axis indicator on the screen or turn off the axis indicator.
6 First 3D	Turn on or off first 3-D window.
7 Second 3D	Turn on or off second 3-D window.
8 Map	Turn on or off map window.
9 Full Screen External View	Turn on or off full screen view when view mode is tower, track, or spot.
A Titles On Windows	Turn on or off titles at the top of the 3-D windows.
B Shader	Turn on or off shading. Off means aircraft and scenery are drawn with lines only.
C Setup Windows	Move, size, turn on or off windows.
D Set Spot Plane	Specify where the spot plane flies and how it follows you when you do aerobatics.
E Display Control	Adjust display speed, make your aircraft's tail and wings visible, and turn on and off approach lighting systems.

2.9 Window and View Controls

Window selection:

Zoom:



First 3-D



Second 3-D



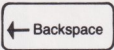
Map

Select the window, then press

In

Out

1X



View mode:

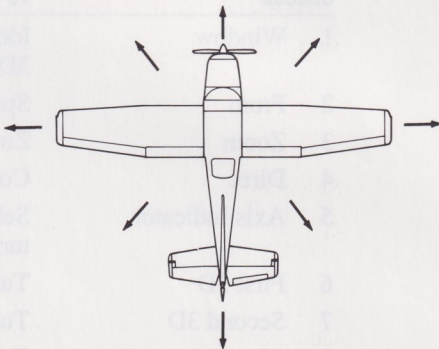
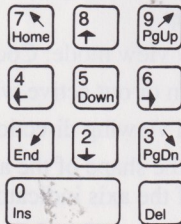


cycles through Cockpit, Tower, Track, and Spot on selected window.

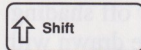
Cockpit Mode View Direction:



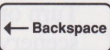
followed by view direction on numeric keypad.



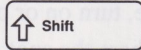
Cockpit Mode Smooth Panning:



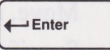
+



Pan upward



+



Pan downward

Function keys on left



Function keys on top



Return to level view

Selecting the Active Window

You can have two 3-D windows on the screen, each showing a different view, and with a different zoom factor. You can also have a Map window on the screen, which allows you to look at a map of the area over which you are flying or taxiing. This is particularly useful in navigation and taxiing around airports.

Only one window is active, or selected, at any time. The name of the active window appears after option 1, Window, on the Views menu. When you want to change a window's view, angle, zoom, or view direction, that window must be the active window. The active window is outlined in white; the other windows are outlined in black.

Select option 1, Window, on the Views menu to cycle through the windows (First 3D, Second 3D, and Map), changing the active window.

You can also select a window using the following keys:

To select	Press
3-D window one	[
3-D window two]
Map window	NumLock

Bringing a Window to the Front

Multiple windows may overlap. To bring a window to the front, select the window. Then press the apostrophe key (').

Selecting the View Mode

Select option 2, From, on the Views menu, or press the S key to cycle through Cockpit, Tower, Track, and Spot view modes. These views have the following characteristics:

View mode	You see
Cockpit	Out of the aircraft's windshield.
Tower	From a stationary control tower; this mode automatically tracks your movements, keeping you in view.
Track	From the ground base, which is not more than five miles from you. In multi-player mode, you track the other player.
Spot	Your airplane, as viewed from a spotter aircraft flying next to you (or behind, below, or in front of you). Use the Set Spot Plane menu to specify where the spotter aircraft will fly.

If option A, Titles On Windows, on the Views menu is turned on, the view mode is displayed at the top of the window.

Zoom Control

In all view modes, you have zoom control. The two 3-D windows and the map window can be zoomed. The zoom control keys affect only the selected window.

Option 3, Zoom, on the Views menu and the zoom indicator on the control panel tell the zoom factor of the selected window. You can zoom in or out (change your field of view) by pressing the window selection key ([,], or NumLock), followed by the plus key or minus key on the main keyboard, not the numeric keypad (see figure 2.9). If you select Zoom on the Views menu, the active window is zoomed. With the mouse, you can zoom the active window by clicking the zoom indicator on the control panel. Click the left side of the digits to decrease the zoom factor; click the right side to increase it. Always click the left button; clicking the right button changes the mouse to Control Yoke mode.

View distortion in wide angle and telephoto views can affect your sense of direction and movement. When landing, taking off, or doing aerobatics, make sure the zoom control is 1X, which is one-times magnification or normal field of vision. Press the window selection key followed by Backspace.

To select and zoom any window:

To zoom	Press
3-D window 1	[, plus key or minus key
3-D window 2], plus key or minus key
Map window	NumLock, plus key or minus key

Once a window is active, you can zoom in or out (press the plus key or the minus key many times) without selecting the window again.

Selecting View Direction

In Cockpit mode, you can look in nine directions. Use the Views menu or the keypad to select the view direction.

On the Views menu, select option 4, Direc, to cycle through the nine view directions. The selected direction appears after Direc on the menu.

To use the keyboard, press Scroll Lock followed by the view direction key on the numeric keypad to select view direction for the active window (see figure 2.9).

Note On newer keyboard designs, the Scroll Lock key is far from the keypad and is awkwardly placed for view direction selection. On these keyboards, pressing * or / next to the keypad serves the same function as Scroll Lock.

Sizing and Moving a Window

Select option C, Setup Windows, on the Views menu to set the size and position of windows. The Setup Windows menu shows five windows that can be sized and moved.

Window	Description
3D One	Two 3-D windows that are independent and can be set for different views, for example, cockpit in one window and tower in the other.
3D Two	
Map	Displays a map of the area over which you are flying.
Control Panel	Shows the instruments; can be moved vertically but not horizontally.
Position Indicator	Small window that shows the position of the elevators, throttle, and ailerons; useful when flying with a full screen 3-D view without a control panel.

All windows can be turned on and off and moved (the panel can only slide up and down). The two 3-D windows and the map can be adjusted to any size.

Changing Window Size with the Keys

The two 3-D windows and map can be set to any size provided they don't overlap the instrument panel.

- 1 On the Views menu, select option C, Setup Windows.
- 2 On the Setup Windows menu, select the Size option for the window you want to size.
- 3 Press the following direction keys to change size:

To make the window	Press
Narrower	Left Arrow
Wider	Right Arrow
Shorter	Up Arrow
Taller	Down Arrow

- 4 When the window size is correct, press Esc or Enter to return to the menu.

Changing Window Size with the Mouse

- 1 Point to the lower-right corner of the window. (Flight Simulator windows have no size boxes.)
- 2 Drag the corner until the window is the width and height you want.
- 3 Release the mouse button.

Moving a Window with the Keys

- 1 On the Views menu, select option C, Setup Windows.
- 2 On the Setup Windows menu, select the Move option for the window you want to move.
- 3 Press the direction keys to move the window.
- 4 When the window is moved, press Esc or Enter to return to the menu.

You can also move a window when in size mode by pressing F, T, H, or B.

The F key moves the window left, the H key moves it right, the T key moves it up, and the B key moves it down.

Moving a Window with the Mouse

- 1 Point to the very top of the window. (Flight Simulator windows have no title bars.)
- 2 Drag the window to its new position.
- 3 Release the mouse button.

Turning a Window On and Off

Turn the five windows on and off by selecting the appropriate Setup Windows menu option. The two 3-D windows and the map window can also be turned on and off by selecting option 6, First 3D; option 7, Second 3D; and option 8, Map, on the Views menu, or by pressing the following keys:

To turn	Press
3-D window one on	[
3-D window one off	[[
3-D window two on]
3-D window two off]]
Map window on	NumLock
Map window off	NumLock NumLock

The double keypresses above require two rapid keypresses of the appropriate key.

The simulation frame rate is highest when a minimum number of windows are turned on. The 3-D and map windows slow the simulation rate the most.

Window Options

Using other options on the Views menu, you can change the main 3-D window to include an axis indicator or to fill the screen, add titles to the windows, and change the appearance of the scenery and aircraft by turning off shading.

Axis Indicator

The axis indicator can be turned on or off by selecting option 5, Axis Indicator, on the Views menu. The four indicator options you can select are Off, V-Shaped, 4-Dots, and Small V.

Full Screen External View

When in Tower, Track, or Spot mode, selecting option 9, Full Screen External View, on the Views menu makes the view in the main 3-D window (First 3D) fill the screen. This lets you see a large area, with high resolution, making it easier to identify planes from the tower.

Titles on Windows

You can add and remove window titles by selecting option A, Titles On Windows, on the Views menu.

Shader

Shading can be turned off to present the scenery and aircraft model using “wire frame” construction (drawn with lines only). This improves display rate, as well as giving the aircraft a CAD (computer-aided design) look. To turn off shading, select option B, Shader, on the Views menu.

Spot Plane Control

Spot plane direction can be adjusted by either pressing Scroll Lock followed by the spot plane’s view direction on the keypad, or by selecting option D, Set Spot Plane, on the Views menu. The keyboard method is more convenient when flying, but the menu gives you more control and lets you specify items such as spot plane altitude and aerobatic view preferences.

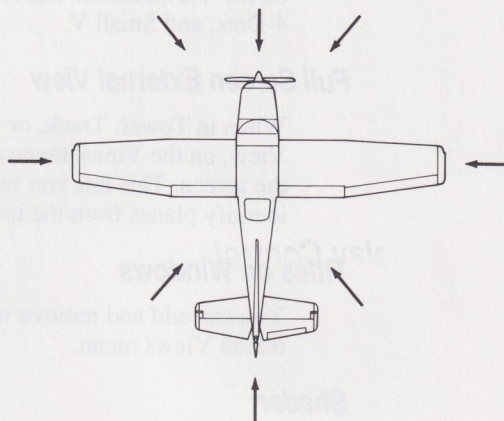
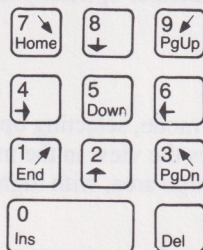
Note The view direction you set on the Set Spot Plane menu will be changed if you change view direction on the keypad.

2.10 Spot Plane View Controls

Spot Mode View Direction



followed by view direction on numeric keypad.



To use the Set Spot Plane menu, set the spot direction (the position where you want the spotter aircraft in relation to your plane) by either pressing the keypad direction keys to move the “view box” (the small box near the aircraft on the menu) to the new position, or dragging it with the mouse. The view box shows the position of the spot plane.

Spot distance and altitude are adjusted by selecting menu options 1 and 2. This determines how far from you the spotter aircraft will fly. Type the distance and altitude in the left column. The right column shows your original settings.

Spot altitude is the difference in altitude between the spotter pilot and your plane. A positive value places the spotter at a higher altitude than your plane. A negative value places the spotter below you. The spotter can never go below ground level.

The spotter plane is positioned in the direction and at the distance you set in the Set Spot Plane menu, for example, 1750 feet off your left wing and 150 feet above you. When you do aerobatics, the spotter plane’s position can change. When you bank the plane steeply and roll upside down, the wing that was pointing east is now pointing west. The spotter plane must switch to your other side if it is to match what you have set in the Set Spot Plane menu. If the spotter plane is jumping from side to side, you will have a hard time watching yourself do aerobatics. A similar situation occurs when you do a loop (pitch upward, then go all the way over).

Option 3, Preference, and option 4, Transition, on the Set Spot Plane menu help solve these problems. You can set them for the kinds of visual special effects you want. Select a Preference first, either Loop or Roll. If you select Roll, the spotter plane flies relative to your heading, not to your wingtip. When you roll, your heading remains the same, and the spotter plane tracks you from one side, letting you watch the complete roll. Loops will still cause a problem though, because as you go “over the top” your heading abruptly changes by 180 degrees. To watch yourself do loops, select Loop. The spotter plane tracks relative to your wingtip direction, which doesn’t change during a loop.

With both Roll and Loop, there are times when the spotter plane must change sides. Rather than changing sides abruptly, the spotter plane gradually moves to the other side, keeping you in view all the while. Think of the spotter plane as a fellow pilot filming you with a movie camera—the spotter plane must fly to your other side. This crossover creates dramatic visual effects. You can set the crossover time by setting option 4, Transition, on the Set Spot Plane menu to Slow or Fast.

Display Control

Option E, Display Control, on the Views menu is used to control how the display appears and how often the screen is repainted.

Choose	To
1 Flicker/Speed Tradeoff	Select the flicker rate and speed. Flicker rate determines how often multiple windows are repainted. Speed determines how often the scenery is repainted. The better the flicker quality, the slower the scenery speed and vice versa.
2 Image Complexity	Specify little scenery for high display rates and complex scenery for slower frame rates. The scenery/complexity tradeoff is area dependent, so the speed increase varies from area to area.
3 See Own Aircraft	Control whether you see your aircraft’s tail and wings when looking out the window in Cockpit mode.
4 Approach Lighting	Turn on and off the approach lighting systems.

Secondary Aircraft Controls

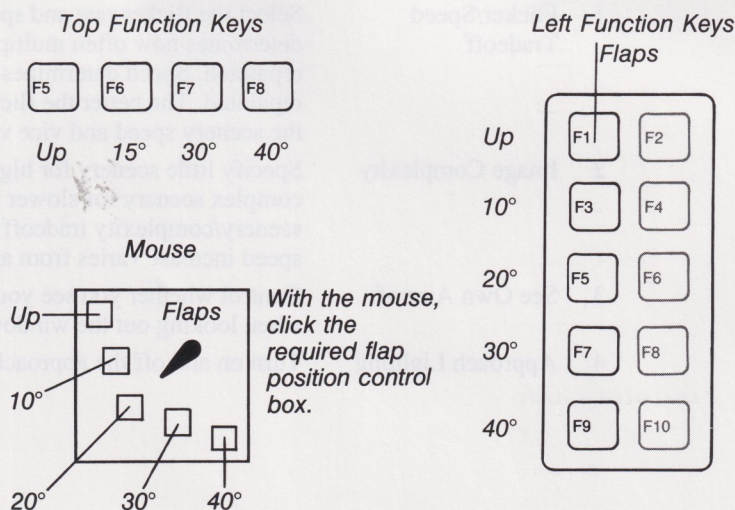
The primary flight controls are the only controls needed to fly the plane. The secondary controls are used to navigate, and to control the engine and the simulator itself. Their positions on the panel and their functions are described in chapter 1, "Basic Window Display and Flight Instruments." A description of how to use these follows. If this is your first flight, you may want to return to this section later.

Flaps

Flaps are movable panels on the inboard trailing edges of the wings. They are hinged so they can be extended downward into the flow of air beneath the wings to increase *lift* (upward force) and *drag* (rearward pull). Their primary purpose is to permit a slower airspeed and steeper angle of descent during a landing approach. They can also be used to shorten takeoff distance or decrease stall speed on a landing approach.

You can adjust the flaps with the keys or the mouse. Figure 2.11 shows the flap controls. Flaps in the Up position are totally retracted; in the 40-degree position, they are totally extended.

2.11 Flap Controls



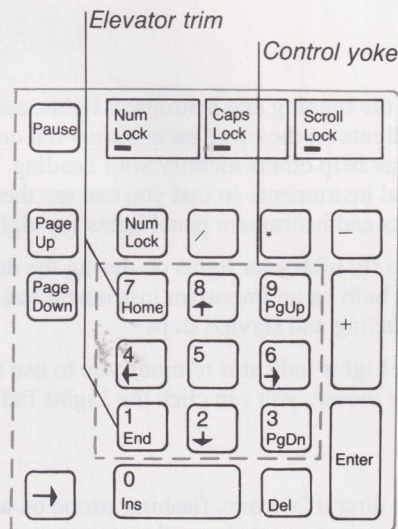
Extending and retracting the flaps affect the plane's performance considerably. Extending the flaps increases both lift and drag. This increases glide angle, which is particularly useful if you are flying too high on an approach and want to increase your rate of descent. Airspeed can be reduced by extending the flaps.

Elevator Trim

The control yoke is directly connected to the airfoils it controls. Different flight attitudes put different pressures on the airfoils. These variations also change the pressure on the yoke. The pilot must counteract these forces to keep the airfoils in their proper positions. Applying steady pressure on the yoke for hours would be fatiguing. *Trim* is used to counteract these forces and relieve the pilot of applying constant pressure on the yoke.

In Flight Simulator, elevator trim is controlled with the 7 and 1 keys on the numeric keypad (see figure 2.12). Pressing the 7 key adjusts the trim downward. Pressing the 1 key adjusts the trim upward. The elevator trim position indicator shows elevator trim position. Remember these keys as the upper-left and lower-left keys of the control yoke.

2.12 Elevator Trim Controls



Carburetor Heat

Carburetor heat is used to prevent icing or to clear ice that has already formed in the carburetor. Apply carburetor heat for a few seconds on a landing approach to avoid ice-caused engine failure.

The H key is the carburetor heat toggle switch. The Carb Heat indicator on the control panel shows whether carburetor heat is on or off.

With the mouse, carburetor heat can be toggled on and off by clicking the Carb Heat indicator.

Magneto Switch and Mixture Full Lean Control

The M key is the magneto switch. After you press the M key, press one of the following numbers in the top row of keys on the main keyboard to indicate magneto setting:

To	Press	Instrument shows
Turn off magnetos	1	OFF
Turn on left magneto	2	LEFT
Turn on right magneto	3	RIGHT
Turn on both magnetos	4	BOTH
Start engine, then turn on both magnetos	5	START
Mixture full lean (engine off)	0	LEAN

Lights

The L key turns on the running and instrument lights, and the red, rotating beacon. *Running lights* are lights on the tip of each wing—red on the pilot's left, green on the pilot's right—that help others identify your heading. Instrument panel lights illuminate individual instruments so that you can see them at night. You must turn on the running lights and instrument panel lights for night flight.

It is not advisable to fly with your lights on during the day. When night arrives you may find that a bulb on an important instrument has burned out. Bulbs are replaced during refueling and service stops.

The "L" next to the Lights indicator reminds you to use the L key to turn the lights on and off. With the mouse, you can click the Lights indicator.

Strobe

The O key turns the aircraft's white, flashing strobe on and off. The Strobe indicator on the instrument panel shows the current status.

You can see the strobe's white flashing light in Cockpit mode at dawn, dusk, or night. If you fly through clouds, the strobe's white flashes of light are reflected into the cockpit by the clouds, possibly disorienting the pilot. You may want to turn off the strobe light to reduce disorientation.

The "O" next to the Strobe indicator reminds you to use the O key to turn the strobe on and off. With the mouse, you can click the Strobe indicator.

Landing Gear

The landing gear key (G) raises and lowers the landing gear in aircraft that have retractable gear. The Gear indicator on the panel shows the current status of the landing gear. You do not have to raise the landing gear when flying. If you do raise it, however, be sure to lower it during the landing approach. Flying with the landing gear down increases drag and slows you down.

The “G” next to the Gear indicator reminds you to use the G key to raise and lower the landing gear. With the mouse, you can click the Gear indicator.

Radio Operation

Flight Simulator has several types of radios and communication equipment, including two navigation radios and two omni-bearing indicators. This section explains how to set and use the communications instruments.

VOR Navigation Radios (NAV 1 and NAV 2)

The NAV radio is an important navigational aid. It is used to tune in VOR (Very high frequency Omnidirectional Range) radio beacons so you can fly toward or away from them. VORs are radio stations that transmit an omnidirectional synchronization signal followed by a circular sweeping directional signal. The NAV receiver in the aircraft decodes these signals to determine what angle or radial you are on. Radials can be thought of as directional beams radiating outward from the VOR station like the spokes of a wheel.

Two NAV radios are provided so that you can tune in two VOR beacons at once. This is useful for doing crosschecks of your position.

You must set the NAV radio to the VOR frequency to receive the appropriate signal. On a real aircraft, two knobs are used to set the frequency. One sets the full megahertz (MHz) frequencies (121, 122, 123, and so on), and the other sets the fractional frequencies in 50 kilohertz (kHz) increments (.00, .05, .10, and so on). Many new radios are 720-channel models with 25 kHz increments, but none of these intermediate frequencies are implemented on Flight Simulator.

Setting the NAV Radio

- 1 Press the NAV key (N).
- 2 If you want to adjust a NAV radio other than the one you most recently adjusted, press 1 for NAV 1 or 2 for NAV 2.
- 3 To change the full megahertz frequency, press the plus key or minus key on the main keyboard, not the numeric keypad.
- 4 To change the fractional frequency (.00, .05, .10, and so on), press the N key twice, in rapid succession, then press either the plus key or minus key until you reach the appropriate setting.

For example, to advance from 111 to 113 MHz, press N, plus, plus. To go from .55 to .40, press NN, minus, minus, minus. For more information on using the NAV radio, see “VOR Navigation” in chapter 16, “Navigation Course.”

The NAV radios can also be set using option B, Nav Radio, on the Nav/Com menu.

To set NAV frequencies using the mouse, click the digits you want to change. The full megahertz frequency and fractional frequency adjust separately. To decrease the setting, click the left side of the digits; to increase the setting, click the right side of the digits. Always click the left button to adjust a setting; clicking the right button changes the mouse to Control Yoke mode.

The NAV 1 radio is also used to tune in the instrument landing system. For detailed information about instrument flying, consult an instrument flight training manual.

Omni-Bearing Indicator (OBI)

The OBI is used with the NAV radio to tune into VOR radio stations. The OBI or VOR indicator is a panel-mounted instrument that lets you determine what VOR radial your plane is on. It also helps you fly along radials toward or away from the VOR station.

Two OBIs are provided. The top OBI (figure 1.1, item 8) corresponds to the NAV 1 radio. The bottom OBI (figure 1.1, item 9) corresponds to the NAV 2 radio.

Setting the OBI

- 1 Press the VOR key (V).
- 2 If you want to adjust an OBI other than the one you most recently adjusted, press 1 for the top OBI, or 2 for the bottom OBI.
- 3 Press the plus key or minus key on the main keyboard, not the numeric keypad, to select the right course and reciprocal course readings.

Each keypress adjusts the course selector by two degrees. Holding down the plus key or minus key rapidly cycles through the degree settings.

The letter “V” on the knob of the OBI indicator reminds you to use the V key to set the OBIs. The OBIs can also be set using option B, Nav Radio, on the Nav/Com menu.

To change OBI settings using the mouse, click the right side or left side of the digits. To decrease the setting, click the left side of the digits; to increase the setting, click the right side of the digits. The three digits adjust together. Always click the left button to adjust a setting; clicking the right button changes the mouse to Control Yoke mode.

OBI 2 and the ADF indicator share instrument panel space. For information about switching between OBI 2 and ADF, see “ADF Navigation Radio Selector” later in this chapter.

DME Source and Ground Speed

DME (Distance Measuring Equipment) tells you how many nautical miles you are from the station tuned on NAV 1. You can select NAV 2 as an alternate source for DME by pressing the B key. The number next to DME on the panel (see figure 1.1-) indicates NAV 1 or 2 as the source.

DME also measures velocity to a station if you are flying exactly toward the station. To get a velocity readout, press F. The ground speed in knots is displayed until you press F again.

ADF Navigation Radio

The ADF (Automatic Direction Finder) is a system that lets you home in on non-directional radio beacons. A three-digit frequency code can be set on the ADF receiver. Before using the ADF, the instrument must be activated. When activated, the ADF indicator replaces the OBI 2 (NAV 2 indicator) on the instrument panel.

Activating the ADF and Setting the Frequency

- 1 On the Nav/Com menu, select option E, ADF.
- 2 Turn on option 4, Activate ADF Gauge.
- 3 Press Spacebar to exit the menu.
- 4 Select ADF by pressing N2.
- 5 Set the frequency by pressing N (left digit), NN (center digit), or NNN (right digit), followed by the plus key or minus key.

To use the mouse, click the digit you want to change. The three digits adjust separately. Always click the left button to adjust a setting; clicking the right button changes the mouse to Control Yoke mode.

Communications Radio (COM Radio)

Use the COM radio to tune to ATIS for weather, airport, and approach information. The charts at the back of this manual note the ATIS frequency for each airport at which ATIS service is available. The same procedure used to set NAV radio frequencies is used to set the COM radio. When using the keyboard, press the C key instead of the N key to select the COM radio.

Transponder

On occasion, Air Traffic Control (ATC) will ask you to transmit a four-digit code or “squawk.” The message from ATC will scroll across the top of your screen. ATC will use the number your transponder transmits to track you on its radar screen.

To adjust the transponder, press T (left digit), TT (second digit), TTT (third digit), or TTTT (fourth digit), followed by the plus key or minus key to change the selected digit.

To use the mouse, click the digit you want to change. The four digits adjust separately. Always click the left button to adjust a setting; clicking the right button changes the mouse to Control Yoke mode.

Flight Instrument Calibration

The altimeter and heading indicator need to be calibrated periodically as you fly.

Altimeter

To set the altimeter to the current barometric pressure, press the altimeter key (A). The altitude reading may change when you do this. To ensure accurate altimeter readings when you have set the Realism option on the Sim menu to Realistic, do this several times each hour.

The letter “A” on the altimeter’s adjustment knob reminds you to use the A key to calibrate the altimeter. With the mouse, you can click the altimeter adjustment knob.

Heading Indicator (Directional Gyro)

Pressing the Directional Gyro key (D) sets the heading indicator to the same reading as the magnetic compass. The magnetic compass does not drift with time as the heading indicator does and always shows a correct reading when stabilized after a turn. Always be sure the magnetic compass has settled down to avoid setting an incorrect direction.

The letter “D” on the heading indicator’s adjustment knob reminds you to use the D key to calibrate the directional gyro. With the mouse, you can click the Heading Indicator knob.

Flying Flight Simulator

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Flying Flight Simulator

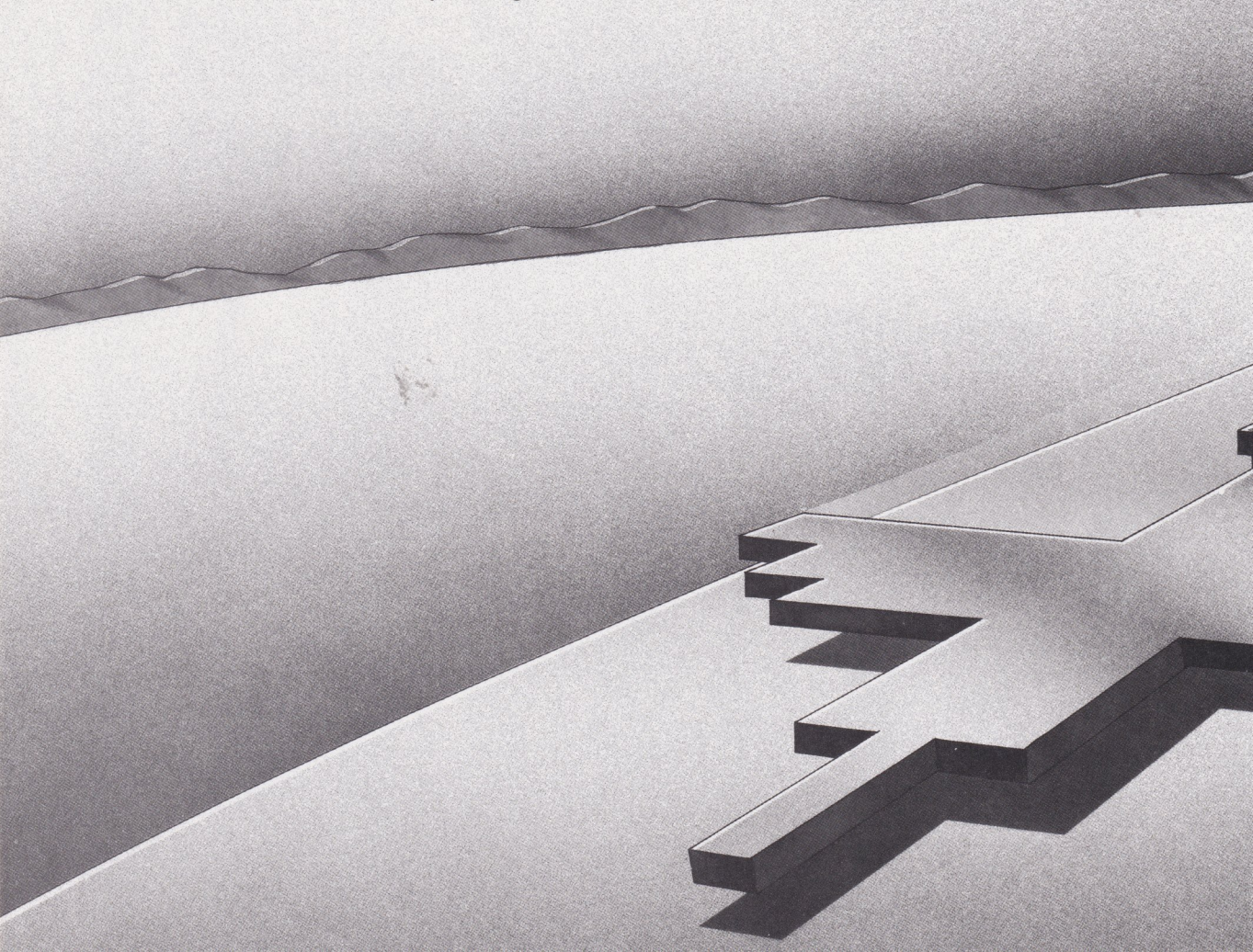
In this section, you learn the basics of flying a single-engine aircraft, a business jet, and a sailplane. You also learn about designing your own aircraft.

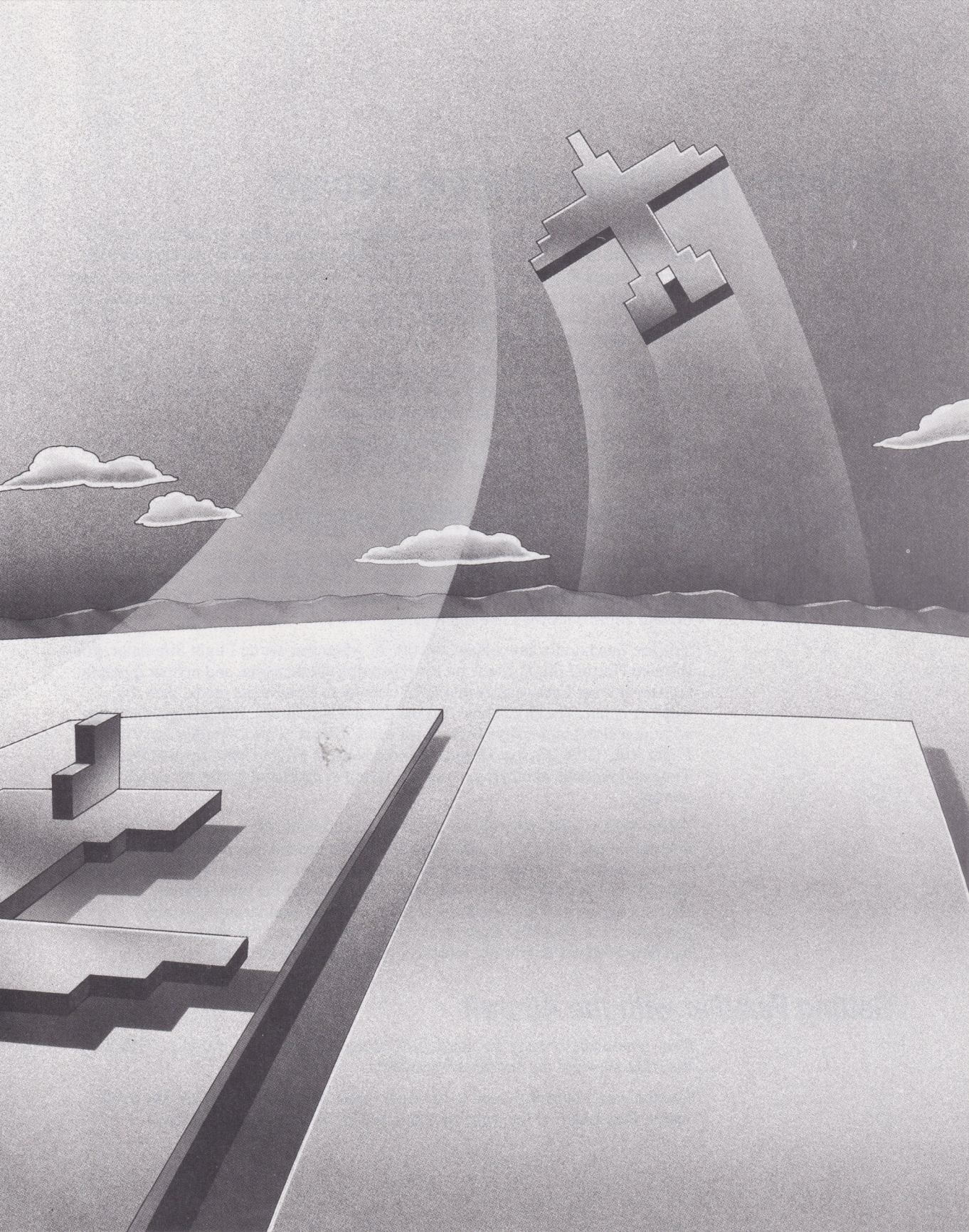
Chapter 3, "Flying the Single-Engine Aircraft," tells you about your aircraft and its instruments, and then teaches you how to taxi, take off, climb, turn, and land.

Chapter 4, "Flying the Business Jet," explains the instruments and controls for the Gates Learjet 25G, and gives you a few flight techniques.

Chapter 5, "Flying the Sailplane," explains the instruments and controls for the Schweizer 2-32 Sailplane, and explains how to stay aloft using ridge lift and thermals.

Chapter 6, "Designing an Aircraft," explains how to select, program, and save aircraft you design.





3: Flying the Single-Engine Aircraft

The single-engine aircraft simulation attempts to accurately simulate the actions and responses of a real aircraft. The Flight Simulator aircraft is closely patterned after a Cessna Skylane RG II (basically a 182 with retractable landing gear). Some of the engine and prop control complexities are not included in the simulation. For more information about this aircraft's performance specifications, see appendix C, "Performance Specifications."

This chapter takes you through the basics of flight. The procedures you follow give you a gradual introduction to your aircraft and tell you how to check instruments, taxi, take off, climb, turn, and land.

Keyboard control is used throughout this tutorial. If you have a joystick or mouse, use the corresponding actions on these devices.

Flying Under Visual Flight Rule (VFR) Conditions

When you start Flight Simulator, you are facing north on the runway at Meigs Field (a small field on a peninsula extending into Lake Michigan) in Chicago. The John Hancock building is on the horizon to your left (northwest). You will take off and climb out over Lake Michigan.

You are lined up for immediate takeoff. If, when you set up Flight Simulator, you selected Normal Flight Mode on the Operating Mode menu, and neither dynamic scenery nor random weather on the Environment Conditions menu, then the weather is fair. The sky is blue and the ground light green, indicating a clear day without a cloud in the sky. There is no wind. This is perfect weather for Visual Flight Rule (VFR) flying. (If you selected Normal Flight Using System Date And Time and random weather, you may be flying at night and it may be cloudy or windy).

When you fly VFR, you rely on ground references and the visible horizon for orientation and navigation. Until you get off the ground, navigation is secondary to flight control. The most important instruments for your first VFR flight are the *airspeed indicator* and the *altimeter*. You will use the other primary flight instruments, as well as the aileron, rudder, elevator, and throttle position indicators. For your first flight, concentrate on what you see out the window and how it relates to altitude, airspeed, bank, and pitch attitude.

Getting Familiar with the Aircraft

Take a moment to study the three-dimensional display on your screen. This is the front view out the aircraft's windshield.

Use the view selector to look to the right (press Scroll Lock, PgUp). Try other views, then return to the front view by pressing Scroll Lock, Up Arrow.

Checking Your Instruments

- 1 Check your altitude. Altitude is measured by the altimeter, in feet above sea level. Although you have not yet left the ground, the altimeter shows an altitude of 592 feet, the elevation of Meigs Field.
- 2 Check the compass. It tells you that you are facing 0 degrees. A 270-degree reading means that the aircraft is pointing west.
- 3 Notice the heading indicator. It shows your direction as 0 degrees. The compass and heading indicator provide similar, but not always identical, readings. Gyroscopic precession and the earth's rotation cause the heading indicator to drift over a short period of time. In reality mode, you must adjust the heading indicator to match the magnetic compass several times each hour by pressing the Directional Gyro key (D).
- 4 It is best to use the map window to taxi around the airport. Take this opportunity to experiment with the map window. Activate the map window by pressing NumLock. To zoom in on a narrower area, press the plus key repeatedly on the main keyboard. To broaden your focus, press the minus key.

Your engine starts automatically when you start the program. However, you don't have enough power to move yet. The airspeed indicator does not register a reading until the aircraft has reached a speed of 40 knots. Because the airspeed indicator is not registering a reading and the view out the window is not changing, you know your aircraft is standing still.

Moving the Control Yoke and Rudder

- 1 Experiment with the ailerons. Turn the yoke full left, then full right, using the Left Arrow and Right Arrow keys. Notice how the adjustments in the ailerons move the aileron position indicator.
- 2 Try the elevators by pressing the Up Arrow and Down Arrow keys, paying attention to how the adjustments in elevators move the elevator position indicator.
- 3 Experiment with the rudder pedals by pressing the bottom-left and bottom-right keys on the keypad. You must be moving to turn the plane, so for now just see how moving the rudder moves the rudder position indicator. Notice that the rudder and ailerons move together. In Auto-coordinated Flight mode, they are locked together. (You are in Auto-coordinated Flight mode when you begin the program.) In Uncoordinated Flight mode, the rudder and ailerons move separately.
- 4 Center the rudder by pressing the 5 key on the keypad.

Taxiing Around the Airport

You are on the runway positioned for takeoff. While you are on the ground, all objects on the horizon are viewed edge-on. Everything in your field of vision is clustered on the horizon.

- 1 If you have not already activated the map window, do so now by pressing NumLock.
- 2 Use the plus and minus keys on the main keyboard to zoom in and out until you get a good view of your position at the airport.
- 3 Begin to *taxi* by applying the throttle. For now, one notch is sufficient, so press the Increase Throttle key (9 on the keypad) once.
- 4 Use the rudder pedals to steer the plane. Turn the rudder left and right by pressing the left-rudder and right-rudder keys to steer the airplane down the runway. Try to stay on the center line. Press the center key (5 on the numeric keypad) to center the rudder and nose wheel quickly, so you can taxi in a straight line.
- 5 Get off the active runway as quickly as possible and practice taxiing around the airport. If you need to make an abrupt stop, cut the throttle and apply your brakes by pressing the Brakes key (.) repeatedly. If you want to roll to a gentle stop, cut the throttle by pressing the Throttle Cut key.

If You Crash

If you crash, your three-dimensional display will go blank temporarily. If you crash into an obstacle or the ground, the word CRASH appears on your screen. If you land in water, the word SPLASH tells you so. In either case, Flight Simulator returns to the location where you began the simulation.

Pre-Takeoff Check

Now that you know how to taxi, prepare for takeoff.

- 1 On the taxiway, taxi to either end of the *active runway* (an active runway has a number at each end).
- 2 Cut the throttle and coast to a stop at the line before the runway. If necessary, apply your brakes by pressing the Brakes key (.) repeatedly.

Now conduct your pre-takeoff check to see if all systems are go.

- 3 Check elevator operation. Move the elevators up and down and then center them.
- 4 Check the rudder and ailerons in the same way. Center them.

- 5 Check the engine gauges. Make sure the oil pressure is correct. The indicator should be centered between L(ow) and H(igh). Also make sure you have plenty of fuel (check both gauges).
- 6 Finally, check for traffic, and then move onto the runway. Check the heading indicator against the magnetic compass. If they do not agree, set the heading indicator to match the magnetic compass by pressing the Directional Gyro key (D) after the magnetic compass has settled.

If all systems are go, you are ready for takeoff.

Takeoff

Before you take off, you may want to read the next sections on straight and level flight, turns, and glides and descents. If you would rather not, don't worry. This is a simulator, after all. You can stop the simulation at any time by pressing the Pause key (P). Press it again to continue.

- 1 Turn the map window off by pressing NumLock twice rapidly.
- 2 Switch to the forward view by pressing Scroll Lock, Up Arrow.

Accelerating Down the Runway

- 1 Apply full throttle.
- 2 As you move down the runway, steer with the rudder, adjusting it to keep a steady course and to avoid zig-zagging. (Remember, pressing the 5 key centers the rudder.)
- 3 Notice that the airspeed indicator shows the rise in speed. When you reach 75 knots, raise the nose by pressing the Down Arrow key rapidly six times. This is the equivalent of pulling back on the control yoke or stick on a real aircraft. Pulling back the control yoke and raising the nose off the ground is called the *rotation*. The runway drops away as you lift off. As the aircraft nose pitches up, the vertical speed indicator registers a positive reading.
- 4 You are airborne. To level out the climb, lower the nose by pressing the 8 key twice.
- 5 Look out of the back window by pressing Scroll Lock, Down Arrow. Return to front view by pressing Scroll Lock, Up Arrow.

Climbing

Flight Simulator, like a real aircraft, climbs by itself and does not require constant adjustments. If you took off as directed, you should be climbing steadily.

- 1 To increase your rate of climb, increase the throttle.
- 2 Raise the elevators enough to hold a constant airspeed. Raising the elevators converts airspeed into vertical velocity.

Adjusting the Throttle

Do not attempt to increase or decrease climb rate by simply raising or lowering the elevators without adjusting the throttle to maintain constant airspeed. Raising the elevators without increasing the throttle will increase your climb rate for a few seconds, but you will soon lose momentum, your airspeed will drop, and the plane may stall. On the other hand, increasing the throttle without applying up elevator will increase your speed, but not necessarily your rate of climb. Understanding the relationship between the elevators and throttle adjustments is basic to successful flight. The relationships between speed, vertical velocity, elevators, and throttle are complex. You will understand them only through practice.

Straight and Level Flight

Once you have reached an altitude of about 3000 feet, gradually make the transition from climbing to straight and level flight.

- 1 Lower the elevators and decrease the throttle to attain a reasonable speed (about 120 knots) without gaining or losing altitude. Remember not to “chase” the vertical speed indicator. Instead, use the altimeter and airspeed indicator as guides, making small adjustments in the throttle and elevators as necessary. Once you have settled into a straight and level flight pattern, your vertical speed reading will drop close to zero.
- 2 Check the altimeter periodically to make sure you are not losing altitude. If you are losing altitude, increase the throttle or raise the elevators.

Turns—Using the Ailerons and Rudder

Turns are made by banking and yawing the plane in the direction you want to turn. The ailerons are used to bank the plane, and the rudder is used to *yaw* it (from left to right). In Auto-coordinated Flight mode, the ailerons and rudder are connected, so you use only the ailerons to control your bank.

- 1 Move the ailerons one notch to the left. You will begin to bank left. Notice how your bank attitude is shown on the attitude indicator.
- 2 When the bank approaches the 20-degree mark, center the ailerons/rudder.
- 3 Check the attitude indicator and turn coordinator again. You are turning.

You will continue turning at the specified angle until you “roll out” of the turn. Flight Simulator is positively stable and makes provisions for wing *dihedral* effects, so if you don’t manually perform a roll out, the plane eventually straightens itself after a few minutes of flight.

- 4 To roll out of a turn, apply the opposite aileron until your attitude indicator shows that you are centered on your course. Timing is the most important factor in rolling out of a turn. As a general rule, apply the opposite aileron/rudder when your heading indicator shows a reading 10 degrees short of your desired heading.

For example, if you want to proceed on a heading of 180 degrees, begin rolling out of the turn when the compass indicates a 170-degree heading. It takes time to level your position. You are still in a bank while rolling out of a turn, so you continue to turn even while you level off.

- 5 Always check the altimeter when you have completed a turn. Turns cause you to lose altitude: the steeper the bank, the greater the loss. To compensate, raise the elevators as you are turning.

Glides and Descents

Glides reduce altitude with little or no engine power. Proper glide technique is essential to a landing approach.

To climb, you increased the throttle and raised the elevators to increase altitude. It seems logical that to descend you would do the opposite—that is, lower the elevators and decrease the throttle. This is not proper glide procedure, however. When you decrease the throttle, the plane drops its nose. Airspeed increases if you decrease the throttle and either keep the elevators where they are or lower them.

- 1 To descend, decrease the throttle.
- 2 Apply a bit of up elevator to hold constant airspeed and to keep the nose from dropping. Judging how much elevator to use takes experience. Watch the world outside when you decrease the throttle. Also study your pitch attitudes as you glide.
- 3 Now, practice gliding. Climb to 5000 feet, level off, and cut the throttle. You will descend at a rapid speed. If your airspeed gets dangerously high (exceeding 140 knots), raise the elevators one notch. This raises your nose and helps control your airspeed.

You can also increase the angle of a glide and reduce airspeed by using the flaps. This is particularly useful if you are too high on a landing approach. Flaps also decrease stall speed during approach and landing.

Practice glides and descents.

Landing

Correct and safe landing is the most challenging part of flying. To land, you fly a foot or two above the runway, slowly applying up elevator until the plane stalls and lands itself.

- 1 Descend until you can see the runway. Every active runway has a number at each end. The line down the center of the runway is your guide for touchdown.
- 2 When you have spotted the runway, align yourself with it and fly toward it at approximately 70 knots.
- 3 If you didn't raise your landing gear after takeoff, it is already lowered. Otherwise, lower it by pressing the Landing Gear key (G).
- 4 Decrease the throttle and raise the elevators to maintain a 70-knot approach. Your approach glide should be a steep one. An engine failure during a steep glide will have little effect on where you land. However, an engine failure during a long, shallow, *power glide* could make you land short of the runway.
- 5 Make a transition to straight and level flight when you are approximately 50 feet above the runway, so that you will be in straight and level flight a foot or two above the runway. This procedure is called the *flare*.
- 6 As you flare, your airspeed starts to drop as the plane loses momentum. As the plane slows, the nose tends to drop. Raise the elevators to keep the plane a foot or two above the ground. As you do so, the nose will rise. On touchdown, your elevators will be nearly all the way up.
- 7 Make sure your rudder is straight before you touch down. The rudder pedals and the rudder control ground steering. You will be whipped off the runway if your wheels are not straight as you touch down. An abrupt turn of the plane on the ground (a ground loop) can severely damage a real aircraft.
- 8 When your speed is reduced enough so that the plane can no longer fly, it will stall and touch down on the runway. If you "fly the plane onto the ground" above stall speed, it may bounce.
- 9 As you touch down, you will hear a sound and see the scenery on the display level off. Use the Brakes key (.) to *bleed off* speed, guiding the plane with the rudder. Continue to apply the brakes until you come to a complete stop.

You have successfully completed your first flight. To practice the fundamentals of flying before attempting advanced flight techniques, taxi to the end of the runway and prepare for takeoff. Don't forget to perform the pre-takeoff check as discussed earlier in this chapter.

One way to improve your landing technique is to practice flying a foot above the runway. To get a lot of practice quickly, approach and fly down the length of a long runway at one foot above the runway. By doing this, you learn what the view looks like just before landing. To practice this technique, select Oakland 27R-Landing Approach from the Mode Library.

Refueling and Servicing

Some of the airports have fuel and servicing facilities. The airports with fuel facilities are noted with an asterisk (*) in the Fuel column in appendix A, "Airport Directory." At the airports in Flight Simulator, these areas are marked by rectangles and are located at the ramp areas. Each rectangle has an "F" inside it. To refuel and have your aircraft serviced, come to a complete stop inside one of these rectangles. Both refueling and repairs occur instantaneously.

4: Flying the Business Jet

Using the business jet, you can go places and view scenery quickly. This mode allows you to fly at altitudes up to 45,000 feet and at speeds up to 445 knots (Mach .82).

Learjet Flight Characteristics

The performance characteristics of this simulation closely match those of a Gates Learjet 25G twin turbojet aircraft. For more information, see appendix C, "Performance Specifications."

Instruments for the Learjet

A Learjet has two turbojet engines and two sets of engine instruments. Instruments for a turbojet engine are different from those of a piston engine. However, Flight Simulator uses the single-engine prop's engine instruments instead of the Learjet's two sets of turbine speed, turbine temperature, and oil temperature gauges. The *tachometer* is recalibrated to show percent of full RPM rather than absolute RPM.

The airspeed indicator is recalibrated to read speeds up to Mach 1 (the speed of sound, 740 mph at sea level). The airspeed indicator shows the *true airspeed* rather than traditional, or indicated, airspeed based on airflow. Indicated airspeed corresponds fairly well to true airspeed on slow aircraft. Because of low air density, a jet at 45,000 feet traveling near the speed of sound has an indicated airspeed that is usually just a few hundred knots. The true airspeed indicator gives a better indication of how fast you are really moving.

The rest of the instruments for the Learjet simulation are the same as those for the single-engine prop aircraft simulation.

Note If you are using display driver option H, EGA 16 Color 640x350, three other instruments change. Carb Heat changes to Spoilers; if you press H, drag increases, resulting in a steeper descent angle. Mags changes to Engs; if you press M, you can control the engines. And the Vertical Speed Indicator is recalibrated to read vertical speeds up to 8000 feet per minute.

Controls for the Learjet

The controls for the Learjet are basically the same as for the single-engine prop aircraft. The jet engines respond more slowly to throttle input because they need time to "spool" up (come up) to speed.

The aileron and rudder sensitivity is a bit higher, and the ailerons can sometimes "get away" from you if the plane gets out of control. If the aileron indicator moves wildly with no keyboard or mouse control, the plane is out of control.

Flight Techniques

There are three things to remember when flying the business jet: fly it with a light touch (slow, steady control movements); it won't respond as quickly as a small plane because it is heavy and has a lot of inertia; and, most important, don't exceed the Mach maximum operating speed (Mmo).

The Learjet 25G has a maximum takeoff weight of 16,300 pounds. By comparison, the Cessna Skylane RG II is only 3100 pounds. Once an aircraft this heavy is on a given course and speed, it takes a lot of effort to slow it down or change its direction of flight. This is particularly true of landings. The best way to land the aircraft is to reach the runway numbers with just the proper speed and *rate of sink*. If you come in too fast, you float above the runway as the plane *bleeds off* speed. If your rate of sink is too high, you hit the runway hard. Extra *rotation* as you near the runway won't help—it will just change the attitude you are in when you smash into the runway.

The Learjet is a streamlined plane, and its two General Electric CJ610-8A turbojets are powerful engines. The biggest problem you will have in this plane is too much speed. Mach .82 is the Mach maximum operating speed. It is indicated on the airspeed indicator. If you exceed it, the overspeed warning system is activated and sounds a warning buzzer. If you don't take action and reduce power, climb, or use spoilers (flap controls) to get the speed down, the "stick puller" pulls up the nose a bit to slow the plane down.

The overspeed dangers can not be overemphasized. This plane is so powerful that you can easily exceed Mmo in level flight with full throttle. If you let the plane get too much over Mmo, supersonic shock waves travel back on the wings until they reach the ailerons. Since the aircraft uses mechanical linkage controls, the yoke (as shown by the aileron indicator) begins to buzz and snatch wildly from side to side. At this stage you are out of control.

Once you are overspeed and out of control, don't be tempted to activate the spoilers (flaps on the simulator) to slow down. They will just drop the nose and make you go faster, putting you in a worse situation. Recover by pulling the power off and gently pulling back on the yoke. Too much yoke pressure will increase the wing loading, moving the shock wave back and making the controls shake even more violently. If all else fails, lower the landing gear. The Learjet is able to withstand the forces of gear down at high speed with only minor gear-door damage. The gear adds drag and helps stabilize the plane. It should slow you enough so you can regain control and fly back to the airport to have your plane inspected and repaired if necessary.

5: Flying the Sailplane

A Schweizer 2-32 Sailplane is one of the Flight Simulator aircraft you can select. This nonpowered, fully aerobatic sailplane offers easy handling characteristics in addition to high performance, making it a fine aircraft for student pilots with an interest in enhancing their skills.

A sailplane instruction demo with messages that highlight important flight concepts is included in Flight Simulator. To view this demo, select option H, Demo Recorder, from the Mode menu, and then select Soaring from the Demo Recorder menu.

The performance characteristics of this simulation closely match those of a real Schweizer 2-32 Sailplane. For more information, see appendix C, "Performance Specifications."

Sailplane Flight Characteristics

In addition to the elevator, aileron, and rudder controls, the sailplane has terminal velocity dive brakes used to control your angle of descent. The dive brakes are surfaces that extend from within the wings to increase drag and reduce the efficiency of the wings. During a vertical dive, you can extend them to prevent the sailplane from exceeding its maximum safe speed. Extend or retract the dive brakes with the function keys you use to control flaps.

The sailplane has no engine for propulsion, so it is always descending unless you fly in an area of ascending air. When the air is rising at a rate equal to or greater than the sailplane's rate of descent, you can maintain your altitude or climb higher, depending on the strength of the lift and your level of skill. Guiding the sailplane through ascending air currents is very challenging as the altitude and duration of your flight depend on the efficiency of the pilot rather than the thrust of an engine. Two of the most common sources of ascending air, ridge lift and thermal lift, are generated in the San Francisco scenery area of Flight Simulator.

Ridge Soaring

When the wind flows into the side of a ridge, it is deflected upward and creates a region of lift that can sustain the flight of the sailplane. As long as the pilot guides the sailplane in the best areas of lift and the wind continues to blow with appropriate direction and velocity, the sailplane can remain aloft for hours and travel great distances.

To experience ridge soaring in Flight Simulator, select the mode Sailplane—Ridge Soaring from the Mode Library. This flight mode releases you into the air currents that are rising along the coast of Marin County, northwest of the Golden Gate Bridge in San Francisco.

You will be heading southeast along the ridge, gradually ascending in rising air. The position of the sailplane relative to the top of the ridge is very important. If you fly too far out over the ocean, the air is neutral or descending because there are no hills to deflect the air upward. Avoid flying on the east side of the ridge, as the air flowing from the west becomes turbulent and descends as it spills over the top. The best lift is usually found just in front of the ridge, but you should explore the ridge area and watch the vertical speed indicator to learn the areas of best lift. The VSI indicates the rate at which you are ascending or descending, relative to sea level. For example, if the needle is on the second notch in the up range of the VSI, you are climbing in lift at a rate of 200 feet per minute.

As you approach the south end of the ridge near the Golden Gate Bridge, prepare to make a 180-degree turn by slightly increasing airspeed and checking your right view for other aircraft. After confirming that your flight path is clear, turn to the right until you are headed northwest, guiding the sailplane slightly in front of the top of the ridge.

When you reach the north end of the ridge, reverse direction again by turning 180-degrees left, away from the ridge, heading southeast to stay in the lift. To avoid flying into the ridge or turbulent air on the opposite side, always turn the sailplane away from the ridge instead of into it.

This flight path of figure-8's is the usual flight pattern while ridge soaring. As your skills increase, try extending your flight range by gaining as much altitude as possible and then exploring the area. As you fly in areas away from the lift, keep in mind that you will need enough altitude to return to the ridge and work your way back up in the rising air. Don't let the sailplane descend too low or you may not have enough altitude to make it to the landing strip near the base of the north end of the ridge.

Thermal Soaring

One of the most challenging sources of rising air currents for the sailplane pilot is thermals—air that is rising due to the sun's heating of the earth's surface. As the sun gradually warms the ground during the morning hours, some areas absorb heat more than others; for example, forests and green fields absorb more heat than desert areas or brown fields. Eventually, a brown field reflects more heat than it absorbs, and releases heat into the atmosphere as a column of rising air. The thermal will rise for thousands of feet, and become a cumulus cloud if there is sufficient humidity in the air.

To experience thermal soaring in Flight Simulator, select the mode Sailplane—Thermal Soaring from the Mode Library. You will be released in an area of abundant thermal activity; by flying over one of the three dark-colored areas of the ground, you will probably fly into a thermal. When you do, the nose of the sailplane pitches up slightly, and the VSI and altimeter indicate you are climbing. You will find that there is more thermal activity during the early afternoon than in the morning due to the heating of the sun.

To avoid flying beyond the thermal and losing the lift, turn to the left or right to begin circling within the thermal. To make efficient use of the lift, try to find the center of the thermal and stay there, circling with a 30- to 40-degree angle of bank. One popular method of locating the center of a thermal is the “270-degree correction.” For example, if the left wing begins to rise, it is likely that a thermal is rising on the left side of the sailplane. By turning to the right for 270 degrees, flying straight for a few seconds, and then circling in the same direction again, you can explore the perimeter of the thermal and locate the area of best lift.

Since the air within a thermal is rising and the air between thermals tends to be descending, you should generally fly slower while circling, and faster while flying between thermals.

Flying in Other Areas

To use the sailplane in an area other than those in the two sailplane modes, use the Cessna to fly to that area. At a flying speed of 70 to 80 knots, select Sailplane from the Aircraft Library. Once you are flying you can select option D, Create Mode, on the Mode menu to save this mode so that you can use it again without using the Cessna.

Another way to get the sailplane going is to use slew mode to raise the plane high in the air, and then turn off slew to drop the sailplane. Use the elevator keys to regain control of the sailplane.

6: Designing an Aircraft

Flight Simulator includes an experimental aircraft that you can alter to design your own planes. Option I, Aircraft Design, on the Mode menu is available whenever an experimental aircraft is selected for option A, Plane. Initially, there is only one experimental aircraft, but you can design and name as many aircraft as you want. Any time you select one of these aircraft, option I, Aircraft Design, will be available.

The Aircraft Design menu includes adjustable parameters you use to design aircraft. As you adjust the parameters, the changes you make are displayed on the screen. Not all configurations are stable, and some won't even get off the ground, but experimenting is safe when you're a Flight Simulator test pilot.

Selecting the Experimental Aircraft

Select the experimental aircraft as you would any other, by selecting the Mode menu, and then selecting option A, Plane, until Experimental Aircraft appears. If many aircraft are available, you may have to select option E, Aircraft Library, to find the experimental aircraft. When Experimental Aircraft is selected, press Spacebar to exit to flight mode. You are now flying the preset experimental aircraft.

Designing the Experimental Aircraft

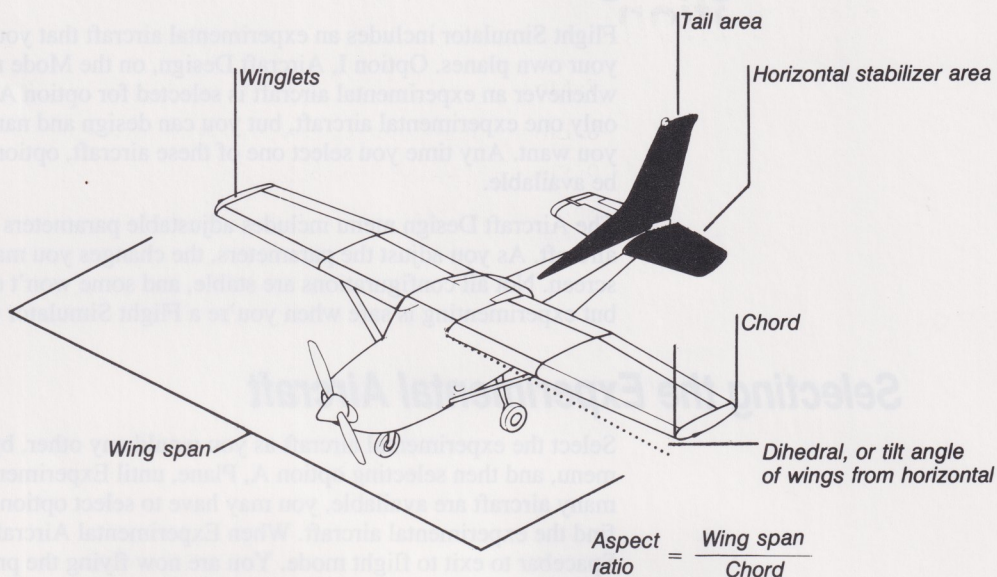
After selecting an experimental aircraft, a new option, Aircraft Design, is added to the Mode menu. At the top of each design menu is a picture of the plane you are designing, plus five options to view the aircraft. Select option 1, Heading, option 2, Pitch, or option 3, Bank. The aircraft will rotate in the direction selected until you select option 4, Freeze. Select option 5, Reset, to reset the aircraft to its original position.

Use the Aircraft Design menu to control the following parts of the aircraft:

- Main Wings—*Dihedral*, span in feet, *aspect ratio*, and winglets (see figure 6.1)
- Stabilizers—Tail area in square feet, horizontal stabilizer position, and horizontal stabilizer area in square feet (see figure 6.1)
- Propulsion—Source (prop, jet, or none), and horsepower (prop) or pounds of thrust (jet)
- Menus—Aircraft colors or other parameters, such as weight and balance, aerodynamics, and saving the plane

Select the propulsion source first as this controls whether the aircraft will resemble the Cessna, jet, or sailplane. When you change the propulsion source, all parameters return to the default settings for that aircraft, and any design changes you have already made are lost.

6.1 Wings and Stabilizers



If you select option J, Color Design, under Menus, you can select colors for 10 parts of the aircraft. If you select option K, Additional Parameters, under Menus, you can adjust the following for your aircraft:

- Weight and Balance—Dry weight, fuel capacity in gallons, center of gravity (in feet, from front of plane), and center of lift
- Files—Aircraft name, filename, and save aircraft to disk
- Aerodynamics—Frontal area in square feet
- Configuration—Gear type

To reset the experimental aircraft to the original settings, select option X, Reset Design Parameters, on the main Aircraft Design menu.

Saving Your New Aircraft

Once you have designed an aircraft, you can name it and save it to disk using the Files options on the Aircraft Design Additional Parameters menu. Select option E, Aircraft Name, and type the aircraft name; if you want to change the filename, select option F, File Name, and type a new filename. Select option G, Save Aircraft To Disk, to save the aircraft. Your new aircraft is now included in the Aircraft Library and can be selected just as you select any aircraft. Since your new aircraft is programmable, the Aircraft Design option will be added to the Mode menu when you fly this aircraft. Use this option to make adjustments to or create modified versions of your new plane.

Flight Simulator Configuration and Navigation

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Flight Simulator Configuration and Navigation

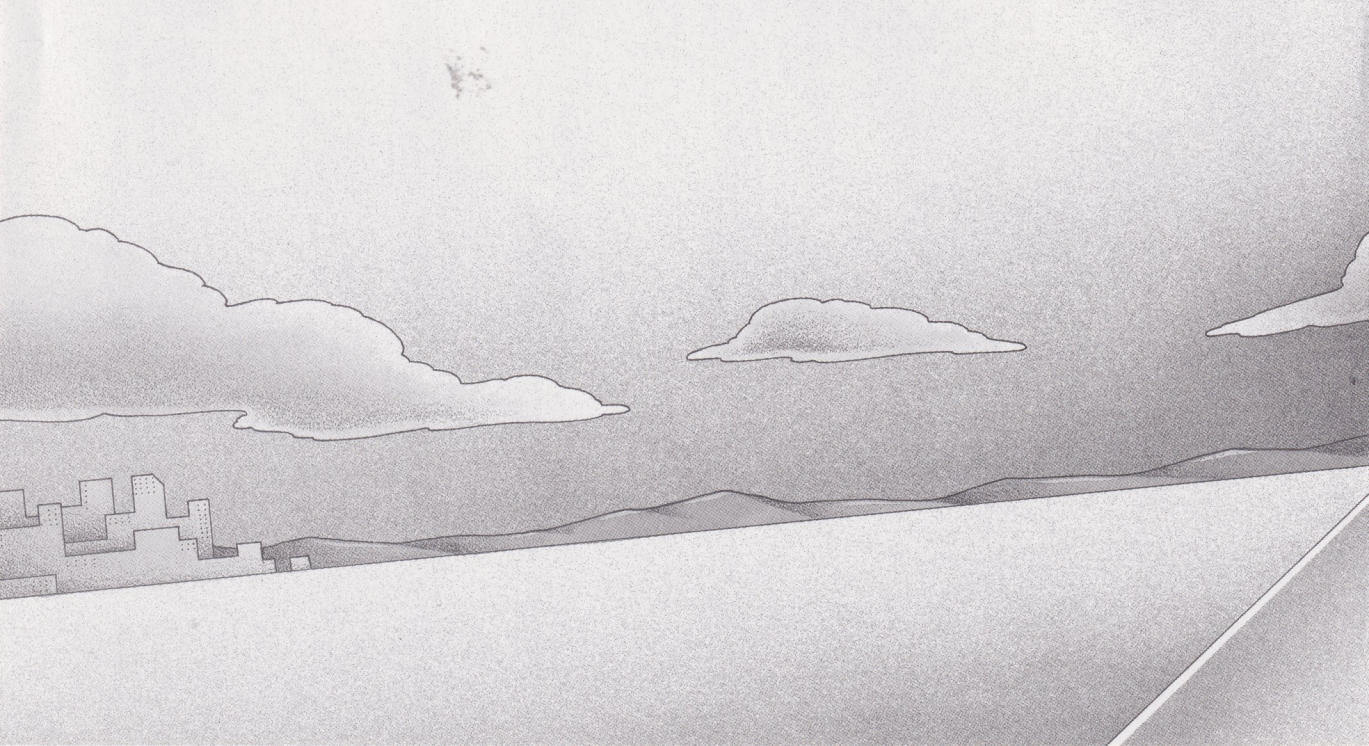
Now that you have taken your first few flights, you are ready to learn about more advanced flying techniques and navigation. Use this part of the manual to learn how to create ever more challenging situations, and about flying around in Flight Simulator's world.

Chapter 7, "Mode Menu—Modes, Libraries, and Flight Recording," describes the six operational modes on the Mode menu, explains the Aircraft and Mode Libraries and how to create your own modes, describes the instant replay feature, and tells you how to use the demo system to record your own demos.

Chapter 8, "Enviro Menu—Setting Environmental Factors," explains how you can use the Enviro menu to set factors that are external to your aircraft, such as season, time, clouds, and winds.

Chapter 9, "Sim Menu—Setting Simulation Control Factors," describes how you can use the Sim menu to control factors internal to your aircraft, such as realism, reliability, and sound.

Chapter 10, "Nav/Com Menu—Traveling Through Flight Simulator's World," explains the map display, how Flight Simulator's world is organized, and how to get around in it. You also learn about the autopilot feature, a navigational tool that pilots find invaluable.





7: Mode Menu—Modes, Libraries, and Flight Recording

The Mode menu includes six operational modes (options 1 through 6), plus the Aircraft Library, Mode Library, and Demo Recorder. The following table shows the Mode menu commands:

Choose	To
1 Normal Flight	Fly around, observe scenery, and navigate using navigational aids. You start at Meigs Field in Chicago, unless you specify another position.
2 Flight Analysis	Select landing analysis, course plotting, or maneuver analysis (chapter 17).
3 Flight Instruction	Select prerecorded flight lessons. Let the instructor show you simple, difficult, and aerobatic maneuvers, or fly the lessons with the instructor guiding you (chapters 13, 14, and 15).
4 Review Logbook	View logbook, edit logbook entries, and turn logbook on and off (chapter 11).
5 Entertainment	Select interesting and fun flight scenarios: multi-player flight, formation flying, World War I Ace, and crop dusting (chapters 18, 19, and 20).
6 Demo	Run a demo showing Flight Simulator's capabilities, or record your own demo to use in Demo mode (chapter 7).
7 Quit	Quit Flight Simulator.
A Plane	Select the plane you want to fly (chapter 7).
B Mode	Select a flight mode (chapter 7).
C Reset Mode	Reset the current mode.
D Create Mode	Create your own flight mode (chapter 7).
E Aircraft Library	View performance and design information about the aircraft (chapter 7).
F Mode Library	View all flight modes (chapter 7).
G Instant Replay	Review the previous few moments of flight (chapter 7).
H Demo Recorder	Record and play back demos (chapter 7).
I Aircraft Design	Adjust or modify your experimental aircraft (chapter 6); appears only when a experimental aircraft is selected in option A, Plane.

Aircraft and Flight Mode Libraries

Flight Simulator stores aircraft type and flight mode information on disk in aircraft and mode files. Each aircraft file contains information about aircraft performance and includes a picture of the aircraft.

A-mode is a set of information that defines where an aircraft should be at the beginning of a flight. Each flight mode file contains information about:

- Aircraft location, altitude, and orientation
- Window sizes
- Menu status
- Time of day and season
- Aircraft control settings
- Wind and cloud information
- Keyboard, mouse, and joystick sensitivities
- Realism and reliability
- Radio settings
- CFPD information and tower position
- Aircraft type

When you create an aircraft or flight mode, it is saved on disk. If you are running Flight Simulator from a floppy disk, be sure that your disk is not write-protected. You can't create modes on a write-protected disk.

Aircraft Library

Flight Simulator comes with five aircraft in its library: a Cessna Skylane RGII, a Gates Learjet 25G, a Sopwith Camel, a Schweizer 2-32 Sailplane, and the experimental aircraft. When you design new planes, these new planes are added to the aircraft library.

Selecting an Aircraft

- 1 On the Mode menu, select option A repeatedly to cycle through the available planes in the Aircraft Library. If many aircraft are available, you may have to select option E, Aircraft Library, and then option 6, See More Aircraft, to find the aircraft you want.
- 2 When you see the one you want, leave it on the menu. This is the plane you will be flying when you exit the menu.

Deleting an Aircraft

You can delete the aircraft you design, but not the five aircraft that come with Flight Simulator.

- 1 On the Mode menu, select option E, Aircraft Library.
- 2 Select the aircraft you want to delete. If the aircraft isn't listed in options 1–5, select option 6 to see more aircraft.
- 3 To delete the aircraft, select option 8, Delete Selected Aircraft.

Viewing a Specification Report

For more details about the planes you are flying, and to get a catalog listing of current aircraft, use the Aircraft Library menu.

- 1 On the Mode menu, select option E, Aircraft Library.
- 2 Options 1 through 5 show planes in the library. Select a new plane by selecting the appropriate option.
To see other aircraft in the library, select option 6, See More Aircraft.
- 3 Select option 7, Performance Spec Report, to see a report on the selected aircraft. This report gives performance and configuration information about the plane.

Mode Library

Flight Simulator comes with several flight modes in its Mode Library. A mode is a set of information that defines where an aircraft is at the beginning of a flight. These modes are interesting flight situations you may want to try.

Selecting a Flight Mode

- 1 On the Mode menu, select option B, Modes, repeatedly to cycle through the available modes in the Mode Library. If many modes are available, you may have to select option F, Mode Library, and then option 7, See More Modes, to find the mode you want.
- 2 When you see the one you want, leave it on the menu. You will be in the new mode when you exit the menu.

Resetting a Flight Mode

A mode defines only where a plane should be at the beginning of a flight. Once you start flying, you are on your own.

- To return to the beginning of the flight mode, select option C, Reset Mode, on the Mode menu. This puts you back to the beginning of the flight.

You can also reset the mode from the keyboard by pressing PrtSc.

Saving a Flight Mode

- 1 Position the plane in the location and configuration you want. Use Pause, if necessary, to freeze the position. A landing approach or sitting on the ramp at a favorite airport make good flight modes.
- 2 Press the semicolon (;) key or select option D, Create Mode, on the Mode menu.

- 3 Follow the instructions on the screen to type a mode title and filename.
- 4 To save the mode to disk, select option 4.

The mode will be saved on the disk (be sure your disk is not write-protected) and will appear in the Mode Library, with the name you have given it. The saved mode becomes the current flight mode.

Viewing a Flight Mode Report

For more details about a flight mode and to see a catalog listing of current modes, use the Mode Library menu.

- 1 On the Mode menu, select option F, Mode Library.
- 2 Options 1 through 6 show modes in the library. Select a new mode by selecting the appropriate option.
To see other modes in the library, select option 7, See More Modes.
- 3 To see the type of information saved for the selected mode, select option 8, Selected Mode Report.
- 4 To delete the selected mode, select option 9. You cannot delete the modes that come with Flight Simulator.

To rename the selected mode, select option A.

These options are useful for Mode Library maintenance.

Mode Loading Options

You can control the mouse, joystick, and keyboard sensitivity, and the aircraft type, when a new mode is selected or when a mode is reset after you crash, after you press PrtSc, or select option C, Reset Mode, on the Mode menu.

If you want the sensitivities to be the same when you use the mode as when the mode was saved, you can turn on option B, Use Mode Control Sensitivities, on the Mode Library menu. You can always change the sensitivities by selecting option D, Mouse, option E, Joystick, or option F, Keyboard Sensitivity, on the Sim menu.

Reading Mode Files from Earlier Versions

To use version 3.0 mode files, just copy the mode files to your version 4.0 directory on your hard disk, or to your copy of the Flight Simulator 4.0 disks. To use version 2.0 mode files, use the following procedure.

- 1 Insert the disk containing the modes into drive A.
- 2 On the Mode menu, select option F, Mode Library.
- 3 Select option D, Load Version 2 Mode File From A:. All 20 user modes will be saved on the disk as files OLD10, OLD11, and so on.
- 4 To rename the modes, use option A, Change Selected Mode Name, on the Mode Library menu.

Changing Startup Mode

You can change the flight mode used when you start Flight Simulator.

- 1 On the Mode menu, select option F, Mode Library.
- 2 On the Mode Library menu, select the mode you want.
- 3 Select option E, Save Startup Mode To Disk. The next time the simulator is started, the new mode is used.

Changing a Supplied Mode

To change a mode that came with Flight Simulator, first load the mode and save it with a new name. Then change the mode and save it again.

Flight Recording

Flight Simulator always records your aircraft's position, making the previous few moments of flight available for your review with the instant replay feature. You can also record and play back demonstration flights (demos). Two demo flights come with Flight Simulator: FS4, a Cessna demo, and Soaring, a sailplane demo. FS4 is the demo that runs when you start Flight Simulator and select a demo mode on the Operating Mode menu. You can also create and record your own demos.

Instant Replay

As you fly, your position is constantly recorded. Use Flight Simulator's instant replay feature to review your previous few moments of flight.

Viewing an Instant Replay

- 1 Press P to pause the simulation.
- 2 On the Mode menu, select option G, Instant Replay. The Instant Replay menu tells you how many seconds of information are available.
- 3 The number of seconds to replay appears after option 1, Replay Seconds Set. If you want to change the replay time, select option 1, type the number of seconds you want to see, and then press Enter.
- 4 If you want the replay to run over and over, select option 2, Auto-Loop.
- 5 If you want to change the replay speed, select option 3, Replay Speed In %. Type the percentage to indicate the replay speed, from 20% (slow) to 255% (fast) of the normal playback rate, and then press Enter.
- 6 Press Spacebar to run the replay.
- 7 When you are ready to resume normal flight, press Esc to exit the Instant Replay menu; press Esc twice if you turned on option 2, Auto-Loop, in step 4. Press P to start the simulation.

Demo Recorder

Flight Simulator contains a Demo Recorder/Player. This system interprets a series of recorded keypresses from a previous flight and sends them to Flight Simulator. The simulator then flies the same way it did when the demo was recorded.

To view the demo that comes with Flight Simulator, select option 6, Demo, on the Mode menu. To view any other demo, follow the steps below. You can change the demo that is played when you either start Flight Simulator or select option 6 on the Mode menu. For more information, see “Creating Your Own Startup Demo” later in this chapter.

Press Esc to stop the demo. Press Esc, P to return flight control to the keyboard. All other keys are locked when a demo is playing.

Playing a Demo

- 1 On the Mode menu, select option H, Demo Recorder.
Options 1 through 5 show the available demos. If many demos are available, you may have to select option 6, See More Demos, to find the demo you want.
- 2 Select the demo that you want to see.
- 3 Press Spacebar to begin the demo.

Adding Messages to a Demo

You can add messages to any demo, at any place in the demo. Messages are added by pressing the comma (,) key during the demo playback at the point when text is to be inserted.

- 1 At the point in the demo where you want to insert text, press the comma key.
- 2 To type a message, select option 1, Insert Text, and then type the message. When you finish typing the text, press Enter.

If you don't want to insert text at this point in the demo, select option 2, Continue Demo Without Inserting Text.

If you want to quit the demo, select option 3, Quit Demo.

After the demo has finished, Flight Simulator asks if you want to save the demo. Press Y to save it, Esc to discard it. If you press Y, type a filename at the prompt.

Recording a Demo

You can make your own demos using the Demo Recorder. The Demo Recorder records keypresses only, not joystick or mouse movements.

- 1 Set up the beginning point of the demo by placing the aircraft where you want it, with the appropriate beginning conditions.
- 2 On the Mode menu, select option H, Demo Recorder.
- 3 Select option D, Recording Interval, to set the interval to either one second or five seconds between recording samples. During demo recording, the lower-left corner of the 3-D window shows the interval setting.

When you are flying the demo, you can change the interval to 1 second by pressing 6 on the main keyboard, or to 5 seconds by pressing 7.

- 4 Select option 7, Begin Demo Recording, from the Demo Recorder menu.
- 5 Press Esc or Spacebar and fly the demo.

Remember, only keypresses are recorded; mouse and joystick movements are not.

- 6 To end the demo, press Backslash, or select option H, Demo Recorder, on the Mode menu, and then option 8, Stop Demo Recording.

The demo is now recorded. Flight Simulator asks if you want to see the demo. Press Y for yes or N for no. Then Flight Simulator asks if you want to save the demo to disk. Press Y to save the demo; press Esc to discard the demo. If you press Y, type a filename at the prompt.

Demo Options

Option 9, Delete Demo, and option A, Change Demo Name, on the Demo Recorder menu let you delete demo files or change their names.

Option B, Demo Loop, is another playback option. When turned on, the demo cycles over again when it is finished. Press Esc to break out of the loop. When turned off, "Demo Finished" appears when the demo is over, and the simulator pauses. Press P to resume normal flight after a demo is finished.

Creating Your Own Startup Demo

- 1 On the Mode menu, select option H, Demo Recorder.
- 2 Select the demo you want Flight Simulator to use as the startup demo.
- 3 Select option C, Save Startup Demo.

8: Enviro Menu—Setting Environmental Factors

With Flight Simulator, you can change environmental flight factors external to the aircraft, such as the season, time of day, clouds, wind, turbulence, and air traffic. Set or change these factors using the following commands on the Enviro menu:

Choose	To
1 Season	Select winter, spring, summer, or autumn.
2 Stars	Turn stars on and off at night.
A Time Set	Set the clock.
B Clouds	Set two levels of clouds, and set thunderstorms.
C Winds	Set surface winds and three levels of winds aloft.
D Weather Generator	Introduce random weather factors.
E Dynamic Scenery	Introduce air traffic and other scenery.

Season

Winter, Spring, Summer, or Autumn can be selected to specify the season. Select option 1, Season, on the Enviro menu to go to the next season.

Each season presents unique flying problems. Winter brings icy runways and startup problems. Summer brings hot, humid days that increase *density altitude* and reduce lift. Each situation requires different skills.

Stars

Select option 2, Stars, to turn stars on or off for night display. The stars are realistic and show true constellations with three magnitude levels.

Time of Day

Flight Simulator automatically sets the visual flight conditions to correspond to the time of day as it appears on the clock. The clock records time in 24-hour format.

Flight Simulator simulates typical visual conditions for four times of day: dawn, day, dusk, and night. Since the visual conditions for dawn and dusk are identical, though reversed, choosing either presents the same flight conditions.

The transition from one flight condition to another varies from season to season, as shown in the following table:

Season	Dawn	Day	Dusk	Night
Winter	7:00	7:30	17:00	17:30
Spring	6:00	6:30	19:00	19:30
Summer	5:00	5:30	21:00	21:30
Autumn	6:00	6:30	19:00	19:30

The transition times are identical for all parts of the world.

Change the time on the clock by selecting option A, Time Set, on the Enviro menu. Use the options on the Time Set menu to advance or decrease hours and minutes, and set seconds to zero. Remember to use 24-hour format when setting a time after 12 noon.

The clock can also be adjusted using the mouse. Point to the digit to be changed (hours, minutes, or seconds) and click the left button. Clicking the left side of the hours or minutes digits decrements the time, and clicking the right side increments the time. Clicking the seconds digit sets the seconds to zero.

Clouds

Select option B, Clouds, from the Enviro menu to activate the Clouds menu for cloud adjustment. You can set two levels of clouds, a top level and a base (bottom) level. For each cloud level, select Tops to type the altitude of the top of the clouds, and select Base to type the altitude of the base of the clouds. Cloud layer altitudes are measured in feet above sea level (MSL), not feet above ground level. Turn a cloud layer off by setting its top and base to zero.

When setting an altitude, select the option you want to change, type the value, and then press Enter.

The Cover option refers to the degree of cloud cover. Select this option to cycle through Clear, Scattered, Broken, or Overcast.

The Deviation option refers to a random number that is added to the cloud height. Breaking out of clouds at exactly 6000 feet is unrealistic. Adding a random factor, whose maximum value (positive or negative) is the value specified in this option, adds realism.

If options on the Weather Generator menu have been turned on, the clouds set on the Clouds menu are ignored.

Thunderstorms

Flight Simulator can simulate thunderstorms—the weather phenomenon that pilots try hardest to avoid. The Clouds menu lets you specify the top and base of the thunderstorm. Tops typically range from 25,000 to 50,000 feet. The Base altitude should be from a few thousand to about 15,000 feet.

Thunderstorm intensity is increased based on how large you make the storms (distance from base to top), plus a random factor.

Select option B, Coverage, to specify the number of thunderstorms. Coverage cycles through Widely Scattered, Scattered, and Dense.

Thunderstorms can also move. Select option C, Movement Dir, to specify a direction in degrees. This is direction the storm is coming from. Select option D, Movement Speed, to specify the speed. Typical speeds are 5 to 30 knots.

Surface Winds and Winds Aloft

Select option C, Winds, from the Enviro menu to set surface wind, plus three levels of winds aloft.

To enter digits on the Winds menu, select the option, type the value, and then press Enter.

Simulate realistic takeoff conditions by setting surface wind speed, direction, and depth. Surface winds are encountered from ground level up to the altitude above ground level specified in option G, Depth. Surface wind direction is specified as magnetic direction.

The top three wind levels (1, 2, and 3) are winds aloft. For each wind level, type the top and base altitudes in feet above sea level (MSL), wind direction relative to true north (not magnetic north), and wind speed.

If options on the Weather Generator menu have been turned on, the winds set on the Winds menu are ignored.

Turbulence

The Turb options on the Winds menu can be set to simulate turbulent air conditions. Turbulence has a range of 0 to 10. Zero indicates smooth air; 10 is the most severe turbulence setting. Type the value for the degree of turbulence you want.

If options on the Weather Generator menu have been turned on, the turbulence set on the Winds menu is ignored.

Weather Generator

Random, real-time weather variations add realism to Flight Simulator’s flying environment. Select option D, Weather Generator, from the Enviro menu to display the Weather Generator menu. This menu contains the following options.

Choose	To
1 Cloud Buildup	Make clouds build up and dissipate as you fly.
2 Front Drift	Create weather fronts that drift through the flight area. You can identify these by their distinctive line of overcast clouds.
3 Wind Changes	Vary the winds at different altitudes.
4 Turbulence Layers	Create turbulence layers.

Random factors and your settings control the weather generator, so turning on an item doesn’t necessarily mean that the action you select will happen immediately.

Dynamic Scenery

Option E, Dynamic Scenery, adds scenery, such as other aircraft, airport service vehicles, boats, and so on, to make flight more realistic. It appears in the San Francisco, Chicago O’Hare, and Chicago Meigs areas. This scenery may be moving around with you. Use the menu options to select the type of objects and the scenery frequency: sparse, medium, or complex.

Because Flight Simulator does not detect other planes in your airspace, planes will go through you if you are in their way or sitting on the runway.

9: Sim Menu—Setting Simulation Control Factors

Controlling the simulation entails setting or changing flight factors that are internal to your aircraft and the Flight Simulator system. These factors include realism adjustments, reliability, pause, and other internal effects. The following table summarizes the commands on the Sim menu:

Choose	To
1 Ground Texture	Add texture to the ground.
2 Crash	Turn crash detection and analysis on and off.
3 Sound	Turn sound on and off.
4 Pause	Pause and restart the simulator.
5 Auto Coordination	Link and unlink the ailerons and rudder.
6 Smoke System	Turn the smoke/spray system on and off.
7 Control Position Indicator	Turn a window on and off that shows the position of the elevators, throttle, and ailerons.
A Realism	Turn several realism effects on and off, and specify flight control level, ranging from easy to realistic.
B Reliability	Set a reliability level, from 100% (totally reliable) to 0% (frequent problems).
C Instrument Panel	Turn off certain instruments to practice flying without them.
D Mouse	Set mouse sensitivity (appendix D).
E Joystick	Set joystick sensitivity (appendix D).
F Keyboard Sensitivity	Set keyboard sensitivity.

Ground Texture

Ground texture (randomly placed patterns on the ground that give a feeling of depth) can be added to the 3-D display. Option 1, Ground Texture, on the Sim menu cycles through Off, Dots, Small Rectangles, and Big Rectangles. Select the one that gives the texture you want.

Crash Detection and Analysis

There are three settings for crash detection on the Sim menu: Off, Detect, and Detect And Analyze. If option 2, Crash, is turned off, the plane “bounces” when it crashes.

In Detect mode, the plane will crash, you will get a crash message, and the simulator will reset.

In Detect and Analyze mode, a graph showing flight trajectory, vertical velocity, and other information appears after a crash. Press Esc to erase the graph and reset the simulator.

Sound

Select option 3, Sound, to turn all sound on and off. A plus beside Sound indicates it is on. The Q key can also be used to turn sound on and off.

Pause

Select option 4, Pause, to stop the simulation. A plus beside Pause indicates that the simulation is stopped. The P key can also be used to pause and is usually more convenient.

To continue the simulation, select Pause again, or press P again.

Auto Coordination

Select option 5, Auto Coordination, to link and unlink ailerons and rudder. A plus beside Auto Coordination means the ailerons and rudder are linked.

Flying in Uncoordinated Flight mode (no plus beside Auto Coordination) means that you must use the ailerons and rudder pedals to fly. This is a more difficult mode, but it allows you to perform maneuvers that are not possible in Auto-coordinated Flight mode. For more information on performing these maneuvers, see “Lesson 4. Uncoordinated Flight” in chapter 14, “Advanced Flight Training.”

Smoke System

A smoke system that emits puffs of white smoke is installed in the aircraft. Select option 6, Smoke System, on the Sim menu, or press the I key to turn the smoke on and off. You can see the smoke from Tower view, or streaming out behind you in Cockpit view.

Control Position Indicator

The Control Position Indicator is a small window that shows the position of the flight controls (elevators, ailerons, rudder and throttle). A square moves left and right from window center to show aileron movement, and up and down to show elevator position. Position arrows on the left and bottom of the window show throttle and rudder position.

Select option 7, Control Position Indicator, on the Sim menu to turn this window on and off.

The window can be moved wherever you want it. For more information, see “Sizing and Moving a Window” in chapter 2, “Aircraft Controls.”

Realism

Option A, Realism, is used to control realism effects. At the top of the Realism menu is a scale showing the Flight Control level. You can set the level from Easy (1) to Realistic (9) by pressing the number you want. The pointer below the line shows the current setting. With the mouse, you can drag the pointer to the flight control setting you want.

The other options on the menu list realism effects. Turn the effects you want on and off by pressing the option letter on the keyboard or clicking the item with the mouse. Turning on these realism effects adds more complexity to the simulation and makes it more challenging to fly.

Menu option	When turned on
A Engine	You must use the magneto switch to start the airplane.
B Elevator Trim	The elevator trim control is activated and the elevator position drifts toward a setting determined by the aerodynamic conditions and the elevator trim setting; you have to adjust the elevators constantly unless you trim the plane properly.
C Gyro Drift	The directional gyro drifts as time goes by, so you should occasionally adjust it while flying.
D Light Burn	Lights occasionally burn out; flying with lights on during the day can burn the lights out.
E Fast Throttle	The engine may bog down and die if you increase your throttle too quickly.
F Instrument Lights	Your panel is blank at night unless you turn your lights on.
G Barometer Drift	The barometer drifts as time goes by, so you should occasionally adjust it while flying.

Reliability

When you select option B, Reliability, you can select a level between Unreliable (0%) and Reliable (100%). The value represents the probability of the plane running reliably. A value of 100 ensures a totally reliable aircraft, while a value of 0 means you'll encounter frequent problems (instrument failures, engine problems, fuel system problems, and so on).

The pointer below the line shows the current setting. To change the setting, press the number (one through nine) representing the reliability you want: one is the least reliable and nine is the most reliable. With the mouse, you can drag the pointer to the setting you want.

Partial Panel

Selecting option C, Instrument Panel, presents a menu of flight instruments. Those instruments you select are blanked, forcing you to fly with limited instrumentation. This is called flying partial panel. It is good flight training to fly without key instruments and by visual references only. You get an idea of what to expect if you have an instrument failure.

There are a few "AUX" gauges on the menu. These are for future installable gauges, and aren't used in this version of Flight Simulator.

Keyboard Sensitivity

Select option F, Keyboard Sensitivity, to control aileron, elevator, and rudder sensitivity. To change a setting, press the number representing the sensitivity you want, where one is low sensitivity (large movement for each keypress) and eight is high sensitivity. With the mouse, you can drag the pointer to the setting you want.

Setting Keyboard Sensitivity

- 1 On the Sim menu, select option F, Keyboard Sensitivity.
- 2 To adjust the ailerons, press 1, and then the number for the sensitivity. Press Esc.
- 3 To adjust the elevators, press 2, and then the number for the sensitivity. Press Esc.
- 4 To adjust the rudder, press 3, and then the number for the sensitivity. Press Esc.

For information about controlling mouse or joystick sensitivity, see appendix D, "Using a Mouse and Joysticks."

10: Nav/Com Menu—Traveling Through Flight Simulator's World

This chapter describes Flight Simulator's world and how to get around in it. First, you learn about the map display, a vital tool in navigation. Then you learn how the world is organized and how to move around quickly without flying. Navigational aids, including VOR, ADF, and ILS radio aids are summarized. Finally, the autopilot, a valuable navigational tool, is covered.

Navigation commands in the Nav/Com menu are summarized in the following table:

Choose	To
1 Scenery	Select scenery on hard disk or floppy disk.
2 Scenery Library	Load a scenery disk.
3 Map Display	Turn map display on and off.
4 Map Zoom In	Zoom in the map display.
5 Map Zoom Out	Zoom out the map display.
6 Autopilot	Turn the autopilot on and off.
7 Air Traffic Control Communications	Enable messages from the tower to be sent to your plane.
8 EFIS/CFPD Display	Project a flight path on your window (chapter 16).
9 Slew	Turn slew mode on and off.
A Position Set	Enter coordinates for your destination position.
B NAV Radio	Adjust the navigation radios.
C COM Radio	Adjust the communication radio.
D Transponder	Adjust the transponder.
E ADF	Adjust the automatic direction finder.
F Autopilot Set	Turn on and enter autopilot information.

Map Display Options and Controls

Select option 3, Map Display, on the Nav/Com menu or press NumLock to see a map of the area over which you are flying. A plus in front of Map Display on the menu indicates that the map display is on. To turn off the map, press NumLock twice rapidly, or select Map Display again on the Nav/Com menu.

You can zoom in on the map to look closely at an airport when taxiing, or zoom out to look at large areas to see where you are. To zoom in, zoom out, or return to the 1X view display, press NumLock, then the plus key, minus key, or Backspace. You can also select option 4, Map Zoom In, or option 5, Map Zoom Out, on the Nav/Com menu for zoom control.

Moving Around in the World

The Flight Simulator world spans more than 100 million square miles, encompassing the continental United States and extending into Canada, Mexico, and the Caribbean. When you are using a scenery disk for Europe or Japan, a second coordinate system allows the world to extend into Europe and Southeast Asia. The center coordinate ($x = 0$, $y = 0$) of the Flight Simulator world is 40 degrees north latitude and 88 degrees 30 minutes west/east longitude, about 30 miles southwest of Champaign, Illinois.

The world database includes 118 airports in five general areas: New York/Boston, Central and Northern Illinois, Seattle, Los Angeles, and San Francisco. You can fly beyond the database areas—into Canada, for example. However, only the five areas mapped in the charts included with this manual have airports and other ground reference points.

Because Flight Simulator is a real-time simulator, flying between distant points (such as Seattle and Los Angeles) takes hours. The single-engine aircraft's fuel tank holds 88 gallons of fuel, enough to take you, under most conditions, approximately 1500 miles from your point of origin. There are no refueling stations outside the "populated" world, so the distance you can fly is limited. The business jet's fuel tank holds approximately 6000 pounds of fuel, so it is capable of cross-country and transatlantic flights.

You can move from one distant area to another without flying by using one of two methods: slewing, or setting destination coordinates using Position Set, both on the Nav/Com menu.

Slewing

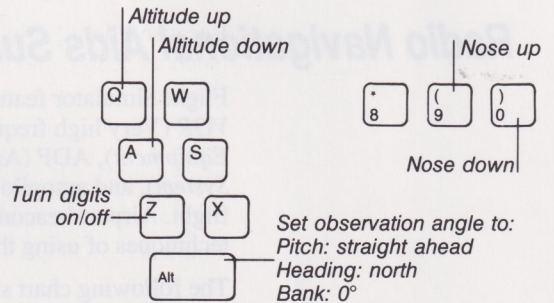
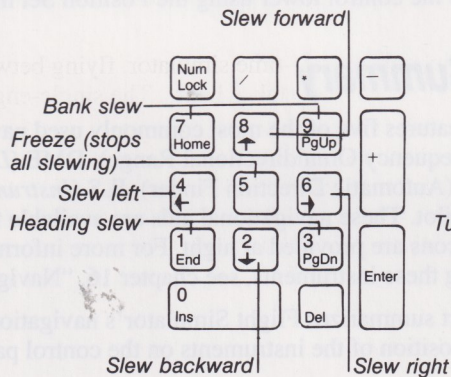
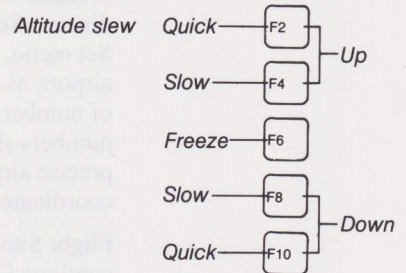
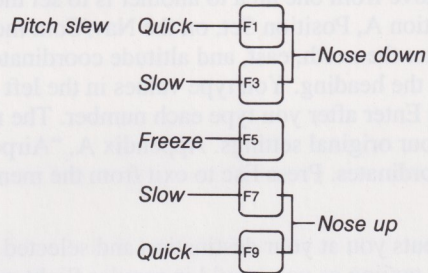
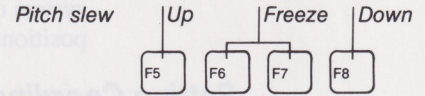
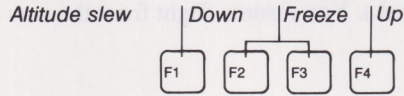
Slewing lets you move very slowly or very rapidly (faster than you could fly) from one point to another, viewing the scenery along the way.

To enter Slew mode, select option 9, Slew, on the Nav/Com menu. Your north and east coordinates and your altitude are displayed at the top of your screen. Press Z to turn them off and on. Scenery appears out the windshield as if you were in normal flight mode.

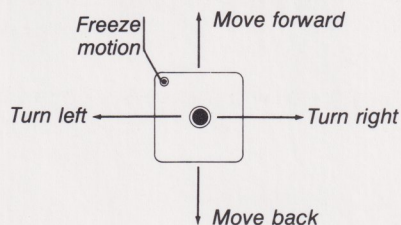
Figure 10.1 shows keys, mouse actions, and joystick movements that control slew directions. There are two controls for altitude and pitch.

10.1 Slew Controls

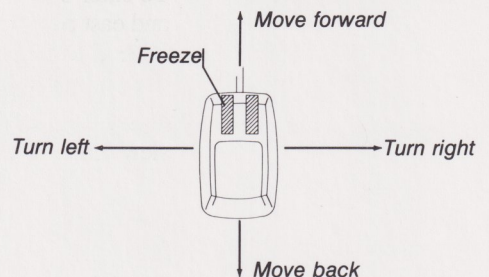
Keyboard



Joystick



Mouse



As you slew, the values next to the east, north, and altitude change to reflect your position.

Exit the slew system by selecting Slew on the Nav/Com menu to turn the system off (no plus mark). You resume flight from the new east and north positions.

Setting Coordinates

A faster way to move from one area to another is to set the destination coordinates. Select option A, Position Set, on the Nav/Com menu. On the Position Set menu, you enter the north, east, and altitude coordinates of your destination airport, as well as the heading. You type values in the left column of numbers. Press Enter after you type each number. The right column of numbers shows your original settings. Appendix A, "Airport Directory," shows precise airport coordinates. Press Esc to exit from the menu and to set the coordinates.

Flight Simulator puts you at your destination and selected altitude. Then continue flying or taxiing as you would in regular flight mode.

You can also place the control tower using the Position Set menu.

Radio Navigational Aids Summary

Flight Simulator features five of the most commonly used navigational aids: VOR (Very high frequency Omnidirectional Range), DME (*Distance Measuring Equipment*), ADF (Automatic Direction Finder), ILS (*Instrument Landing System*), and autopilot. These navigational aids are available for day or night flight. Airport beacons are provided at night. For more information about the techniques of using these instruments, see chapter 16, "Navigation Course."

The following chart summarizes Flight Simulator's navigational aids. See figure 1.1 for the position of the instruments on the control panel.

Instrument	Full Name	Function
NAV 1	Navigation Radio 1	Receives VOR stations and drives OBI 1.
NAV 2	Navigation Radio 2	Receives VOR stations and drives OBI 2.
OBI 1	Omni-Bearing Indicator 1	Has VOR 1 tracking needle, ILS tracking needle, TO/FROM flag, and Glideslope needle.
OBI 2	Omni-Bearing Indicator 2	Has VOR 2 tracking needle and TO/FROM flag.
OMI	Outer, Middle, and Inner Marker Lights	Lights flash and a tone is emitted when in the vicinity of an outer, middle, or inner marker beacon when making an ILS approach.
COM	Communication Radio	Receives ATIS, tower, and multi-player communications.
DME	Distance Measuring Equipment	Tells distance and speed toward VOR station, or other plane in multi-player mode; use NAV 1 or NAV 2.
ADF	Automatic Direction Finder	Tracks NDB beacons and other aircraft in multi-player mode; takes the panel space of OBI 2 when activated.
XPDR	Transponder	Transmits code to air traffic control.

Autopilot

On long cross-country flights, an autopilot is a good flight aid. It relieves a pilot of the tedious chore of holding a desired altitude and tracking a heading or VOR. This reduces fatigue and lets the pilot devote more time to other flight tasks such as instrument scan, radio communications, or approach preparation.

An autopilot's wing leveler (a separate system in many planes, but integrated with the autopilot in Flight Simulator) keeps the wings as level as possible to keep you from going into an unexpected turn or roll. This is especially useful in turbulent conditions in clouds. If you don't keep an eye on the attitude indicator continuously, which is hard to do while preparing for an instrument approach, you can end up in a steep bank or upside down and not even realize it until you are in an emergency situation.

Setting the Autopilot

- 1 Select option F, Autopilot Set, on the Nav/Com menu.
- 2 To keep the wings as level as possible, turn on option 1, Wing Leveler.
To lock on to the VOR radial, turn on option 2, NAV 1 Lock.
To lock on to a heading, turn on option 3, Heading Lock.
To lock on to an altitude, turn on option 4, Altitude Lock.

A plus beside a lock tells you that the lock is on. Any combination of locks can be on at the same time.
- 3 When you select Heading Lock or Altitude Lock, a cursor appears in the field to the right of the option. Type the value you want, and then press Enter.

NAV 1 Lock tracks the VOR radial that you have set on the Omni-Bearing Indicator. A good way to set up NAV 1 Lock is to track the VOR manually as described in "VOR Navigation" in chapter 16, "Navigation Course." Then select Autopilot Set on the Nav/Com menu and turn on NAV 1 Lock. The autopilot tracks the radial while you perform other flight tasks.

Once the autopilot is set, it starts tracking the locked functions. You can turn the autopilot on and off at any time by pressing Z, or by selecting option 6, Autopilot, on the Nav/Com menu. With the mouse, you can click the autopilot status indicator to turn autopilot on and off.

The autopilot status indicator on the control panel indicates whether the autopilot is on or off. This indicator appears below the artificial horizon.

Flight controls for the locked functions (ailerons when the wing leveler is turned on, for example) respond sluggishly as you fight the autopilot. If you need to regain full control for a while, press Z to turn the autopilot off temporarily.

Air Traffic Control Communications

Option 7, Air Traffic Control Communications, on the Nav/Com menu allows you to communicate with the tower. When this option is turned on, you will be instructed to tune your transponder to a specific frequency by air traffic control (ATC) when requesting take-off clearance. You can also request a landing clearance.

The Enter key is your microphone button for communicating with the tower. When you want to request takeoff or landing clearance, press Enter and a menu of messages will appear. Select what you want to say and then press Ins to transmit your message to the tower. Air traffic control will soon answer your request.

Converting and Using Scenery Files and Disks

Converted scenery files and SubLOGIC scenery disks can be used with Flight Simulator 4.0. To use scenery files or disks, put all scenery files you want to use in the Flight Simulator subdirectory, or place a SubLOGIC scenery disk in disk drive A.

You can convert your older SubLOGIC scenery disks to the version 4.0 format, and copy them into your Flight Simulator subdirectory.

Converting Scenery Files

- 1 Change to the disk drive or directory containing the Flight Simulator files.
- 2 At the system prompt, type **converts** and then press Enter.
- 3 At the prompt, insert your scenery disk into the disk drive, and then type that drive's letter.

A list of all possible scenery disks will appear on your screen.

- 4 At the prompt, type the letter corresponding to the scenery disk you are converting.
- 5 At the prompt, type the letter of the drive where you want the scenery copied.

The scenery filename will be SD-*.SCN, with the * replaced by the numbers 1 through 12, or JPN, SFS, or EUR. The files generated by CONVERTS are placed in the default subdirectory on the drive you indicated. Only these new scenery files are scanned for automatic scenery loading.

Option A, Automatic Scenery Selection, appears on the Scenery Library menu only if there are two or more converted scenery files in the Flight Simulator subdirectory.

Using SubLOGIC Scenery Disks

- 1 On the Nav/Com menu, set option 1, Scenery, to Floppy Disk A:.
- 2 Press Spacebar to return to flight mode.
- 3 During flight, insert a scenery disk into drive A and press Ctrl+E. The scenery disk will be loaded and the Scenery Library will be displayed.
- 4 Make your selections from the menu.

Using a Scenery File

- 1 On the Nav/Com menu, set option 1, Scenery, to Hard Disk.
- 2 Press Spacebar to return to flight mode.
- 3 During flight, press Ctrl+E. The Scenery Library menu will appear.
- 4 Make your selections from the menu.

The Scenery Library menu, also available as option 2, Scenery Library, on the Nav/Com menu, lists all available scenery files. Select the one you want to use.

If more than one scenery file appears on this menu, option A, Automatic Scenery Selection, also appears.

Option 1, Scenery Disk in A:, lets you change scenery by placing a SubLOGIC Scenery disk in drive A. If you are using scenery disks extensively, it is more convenient to press Ctrl+E to load scenery than to use option 2, Scenery Library, on the Nav/Com menu.

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Flight School

Welcome to Flight Simulator Flight School. While you are here, you will learn the basics of flight. Those of you who don't wash out will go on to learn some of the finer points, such as aerobatics and navigation.

You veteran pilots who are just taking a tour through Flight School will be interested in the Logbook, and in Flight Analysis and Course Plotting—Flight Simulator features that can help you keep track of your flights or polish your skills.

A quick visit to the Flight School research labs lets you fly a new system that the aviation community is working with—a Command Flight Path Display, potentially the navigation tool of the future.

Chapter 11, "Logbook," gets you started keeping your logbook up to date.

Chapter 12, "Ground School," teaches you the basics of flight physics, attitude flying, and various rules of flight.

Chapter 13, "Basic Flight Training," takes you through basic flight techniques in 10 flying lessons.

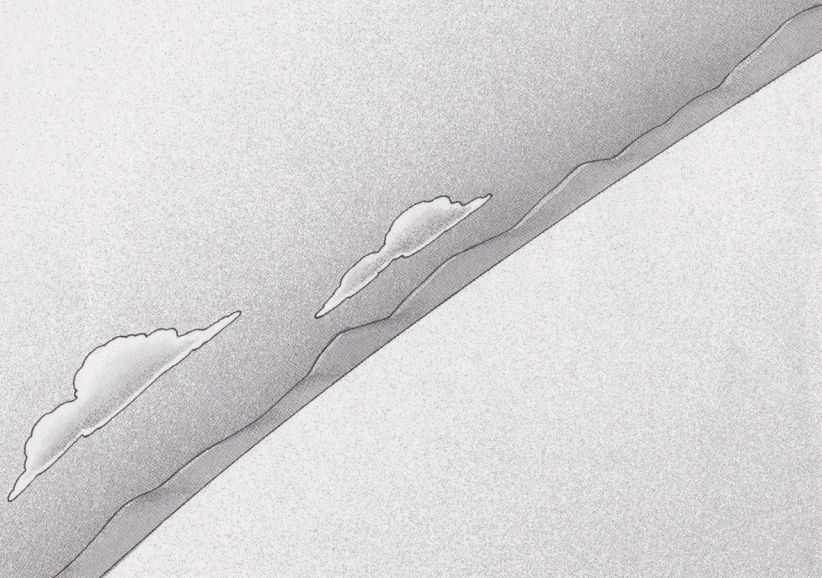
Chapter 14, "Advanced Flight Training," takes you through more advanced flight techniques and maneuvers.

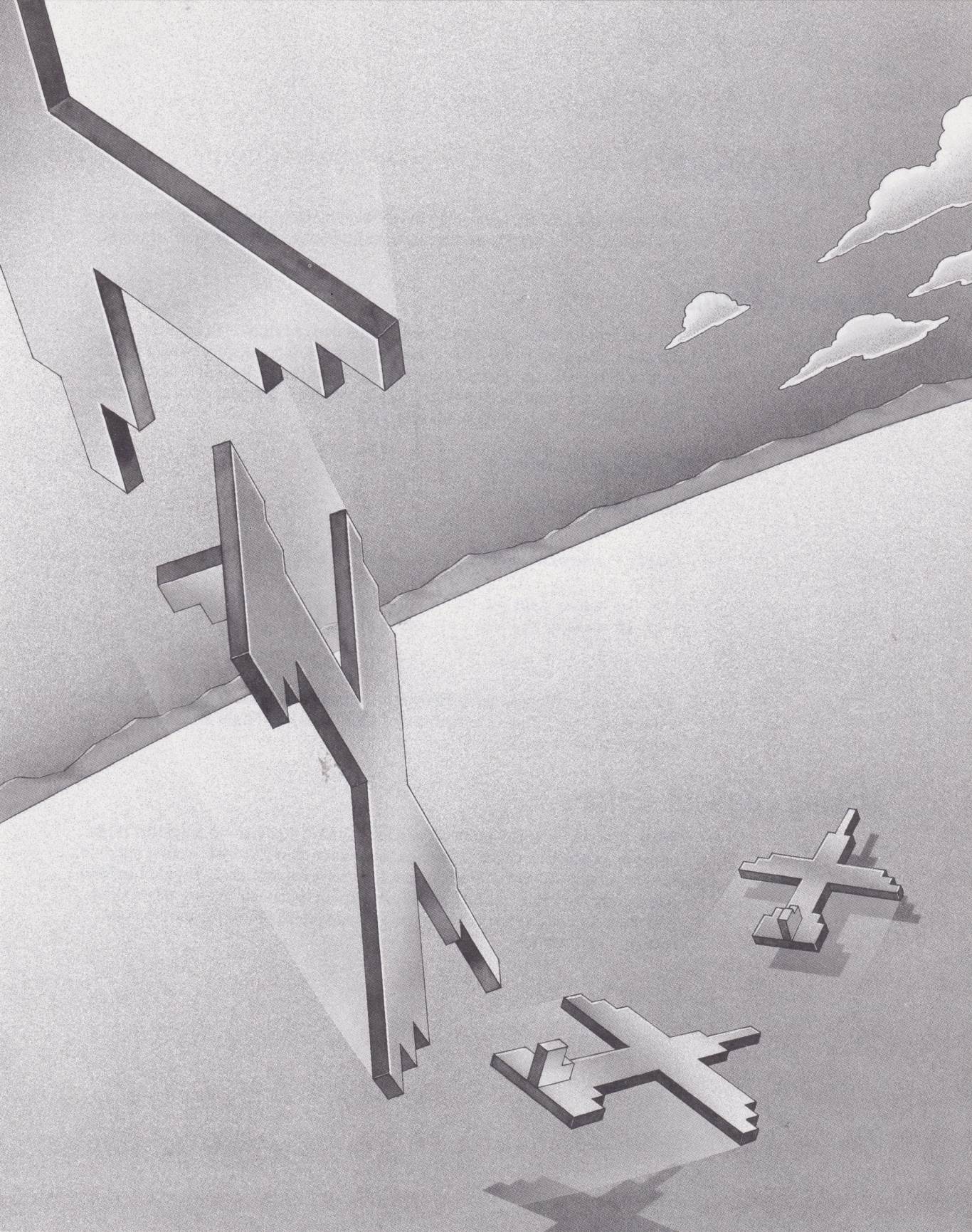
Chapter 15, "Aerobatics Course," teaches common aerobatic maneuvers.

Chapter 16, "Navigation Course," presents topics in radio navigation using radio navigational aids. It also shows you a Command Flight Path Display. It's quite interesting and fun.

Chapter 17, "Flight Analysis and Course Plotting," explains Flight Simulator's landing and maneuver analysis system, and the course plotting system.

Good luck in Flight School!





11: Logbook

Pilots keep track of the hours they have flown by recording them in a logbook or pilot log. Flight Simulator can maintain logbooks for any number of pilots.

Logbook Format

The logbook format is an abbreviated format derived from official pilot logbooks. These logbooks usually also include aircraft category (single engine, multi engine), aircraft identification numbers, number of landings, and whether the landings are simulated or actual. Flight Simulator automatically determines if you are flying day, night, or on instruments.

11.1 Flight Simulator Pilot Log

STANDARD PILOT LOG

DATE	AIRCRAFT MODEL	TO/FROM/REMARKS	DAY	NIGHT	INST.	TOTAL
12-30-90	Gates Learjet 25	VNY to SAN	0.0	1.0	0.0	1.0
01-01-91	Cessna Skylane	CMI to BMI	1.5	0.0	0.0	1.5
TOTALS			1.5	1.0	0.0	2.5

The date of the flight is taken from your computer's clock. Day or night logging is based on your flying time before and after sunset on Flight Simulator's instrument panel clock.

Making Logbook Entries

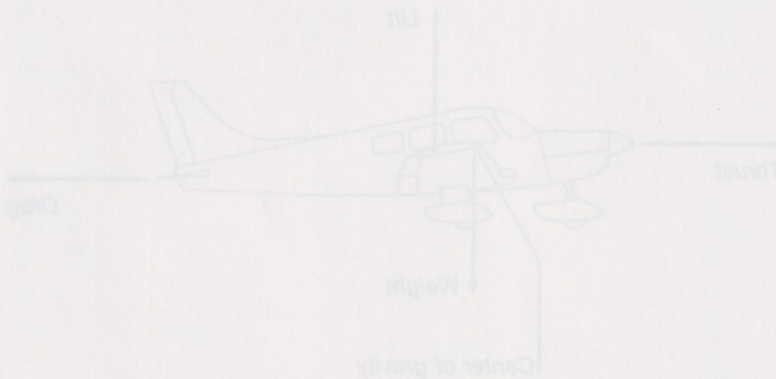
When you start Flight Simulator, you are asked if you want to enter this flight in the logbook. You can also turn logbook entry on or off by selecting option 4, Review Logbook, on the Mode menu, then selecting option 2, Toggle Logbook Activation. For more information about naming logbooks and logging a flight into the logbook, see "Answering the Startup Questions" in the introduction section, "Welcome."

Editing or Printing Your Logbook

The logbook is stored in a standard ASCII text file on disk. The filename is *name.log*, where *name* is replaced with up to eight characters of the name of the pilot's logbook (usually the pilot's first or last name).

You can edit the logbook by selecting option 4, Review Logbook, on the Mode menu, then selecting option 1, Edit Logbook Entries. You can also edit the logbook when you exit Flight Simulator. The Date field and the To/From/Remarks field are the only fields you can edit. The controls you use when editing are explained on the screen.

Print the logbook by sending the file to a printer using the copy command in your operating system. For example, on a system running MS-DOS, type **copy johnf.log com1**. You can also print the logbook using the print command in a text editor program.



12: Ground School

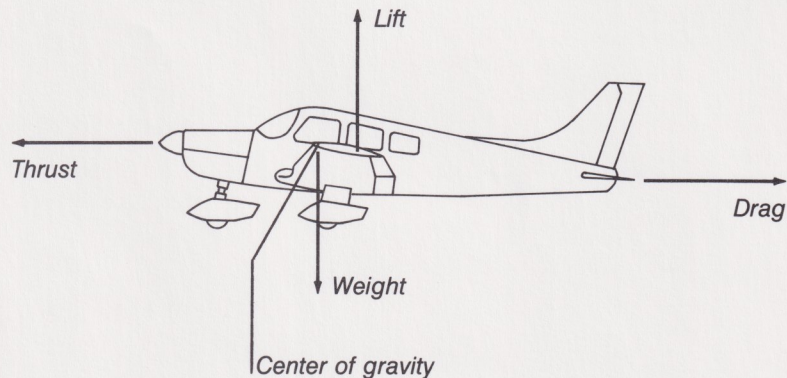
When learning to fly, you must take to the books as much as you take to the sky. The *Flight Training Handbook*, published by the FAA (available from Sporty's Pilot Shop, and other book suppliers) contains all the topics that you must learn. The handbook includes such topics as the basics of flight, engines and airplanes, controls and maneuvers, traffic patterns, taking off and landing, and emergency flight. These topics are just a starting point. You must also learn about aviation weather, radio navigation, instrument flying, and operating in controlled airspace and traffic areas, not to mention the Federal Aviation Regulations (FAR).

This chapter briefly covers a few of the important points that you might learn in your first day or two of ground school. All the information presented here is from actual flight training material, so everything you learn also applies to a real aircraft. When it comes to flying a real aircraft, however, there is no substitute for a flight course that covers all the above topics in depth and puts you through 50 or more hours of flight time with an instructor. This does not mean that Flight Simulator is just another entertaining computer program. If the past is any indication of the future, many of you new Flight Simulator pilots will go on to get your pilot's license from a certified flight school, and when you do, look back fondly at your old alma mater—Flight Simulator Flight School.

Balance of Forces

There are four components that must be balanced when flying an airplane: lift, drag, thrust, and weight (see figure 12.1).

12.1 Balance of Forces



The four-force relationship is more complex than it first appears because the forces interact under the pilot's control.

Lift

Lift is influenced by two things: how fast you go, and your *angle of attack* to the oncoming air—generally how far you pitch up and raise the aircraft's nose.

The faster you go, the more lift you produce. The greater the angle of attack, introduced by pulling back on the control yoke, the more lift you produce.

You can only go so far on the angle of attack, however, before the wing “stalls,” and you have no lift at all. This happens at an angle of attack between 9 and 20 degrees, depending on the airfoil (wing cross-section) design.

Drag

Drag is the resistance that pulls the plane back and balances out the thrust from the engine. Drag increases as your speed increases, proportional to the square of the velocity. Basically, if you go twice as fast, you have four times as much drag.

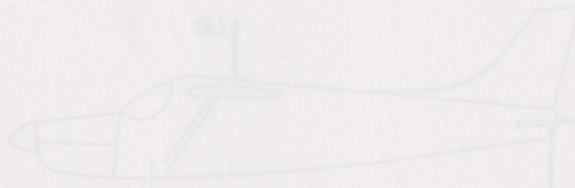
Thrust

Thrust moves the plane forward through the air. It makes the plane go faster until drag is equal to thrust, and that's as fast as you can go.

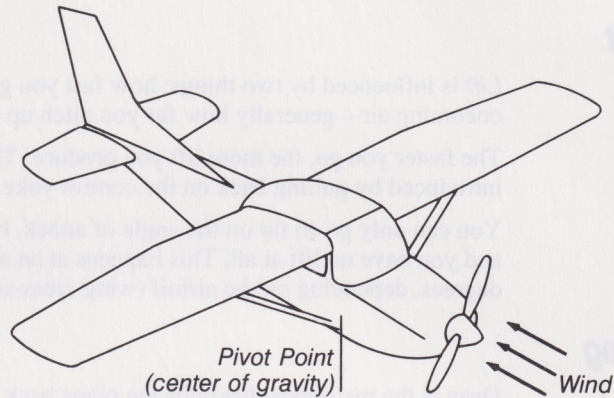
Horsepower is a measure of force over a distance during a defined period of time. When you double your speed, you square your drag (which takes four times as much horsepower to balance) and double your distance covered over time (which takes twice again as much horsepower). Basically, horsepower requirements go up as a function of velocity cubed. It takes eight times as much horsepower to go twice as fast.

Stability, Weight, and Balance

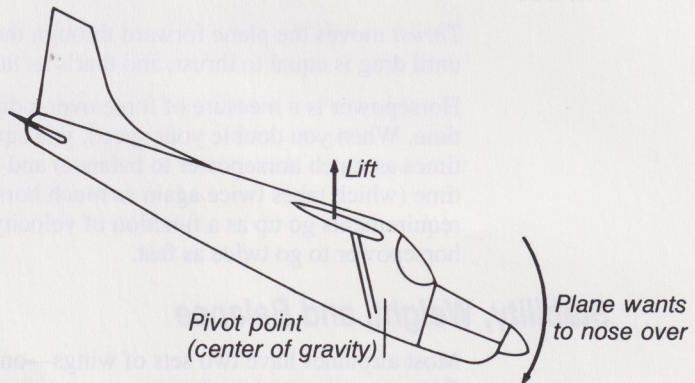
Most airplanes have two sets of wings—one set in front and a small set in back. Did you ever wonder why two sets are needed? Did you ever wonder why airplanes can't fly backwards? The answer lies in stability.



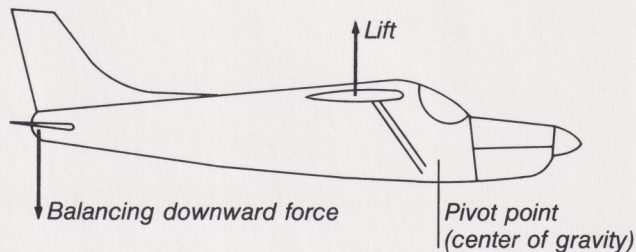
12.2 Aircraft Stability



a) Wings behind center of gravity cause plane to weathervane into the wind and point forward, instead of flipping around and pointing backward.



b) The plane's lift behind the center of gravity tends to make the plane nose over.



c) Small wing at the back pushes the tail down and balances the forces.

An airplane must fly straight and smoothly through the air for its wings to work properly. This happens because of the *weathervane effect*—the tendency to pivot around a pivot point (the center of gravity on an airplane) until the airfoils are in back of the pivot point in relation to the oncoming wind (see figure 12.2a). To make an airplane stable, you must put the wings (actually the wings' center of lift) behind the plane's center of gravity.

This also makes an aircraft want to *nose over* (see figure 12.2b). To prevent this, a small “wing” can be added to the back of the plane to push the tail down and balance the forces. This wing is also behind the center of gravity so that it, too, acts in a positive, weathervane way (see figure 12.2c).

There are two points to note here—one just interesting, and the other very important. The interesting point is that the front wing pushes up, and the rear one (horizontal stabilizer) pushes down. The important one is that when you go on a trip, especially a long cross-country one with a lot of baggage and friends, be careful how you load your aircraft. If you put too much weight in the rear and get the center of gravity behind your center of lift, your plane is no longer stable and will not want to fly. You won't stay in the air very long.

For more information about aircraft loading, and weight and balance diagrams, see the “Aircraft Loading” and “Weight and Balance Diagram” sections in your airplane owner's manual and flight textbooks.

Attitude Flying

Pilots learn to fly using *attitude flying*. Attitude refers to the aircraft's orientation (notably pitch and bank) to the world around it.

Airplane control is composed of three components:

- Pitch control (see figure 2.4), using elevators to raise or lower the nose in relation to the horizon
- Bank or roll control (see figure 2.2), using ailerons to control the desired bank angle in relation to the horizon
- Power to establish or maintain desired airspeeds in coordination with attitude changes

The following visual references are used for aircraft control:

- Airplane's nose (or axis indicator on Flight Simulator) shows pitch attitude and flight direction
- Airplane's wingtips show pitch attitude and bank
- Windshield shows angle of bank

The following flight instruments (see figure 1.1) are used as instrument references for aircraft control:

- Attitude Indicator shows pitch and bank
- Heading Indicator shows direction of flight
- Altimeter shows altitude
- Vertical Speed Indicator shows rate of climb or descent
- Airspeed Indicator shows the results of power or pitch changes through changes in the airspeed

The basic flight lessons in chapter 13, “Basic Flight Training,” will help you learn how to use controls to attain the proper attitude in relation to the horizon, using inside and outside references, and the importance of checking all reference points.

Information Scan

With all the flight instruments and visual cues used in flying, it’s good to develop a systematic way of scanning your instruments and visual “out-the-window” displays to make sure all important items are being looked at, at least once in a while.

For the visual flights we’ll be taking, you should begin your scan out the front window, and then follow this sequence:

- 1 Right window, then back to the front window.
- 2 Left window, then back to the front window.
- 3 Six primary instruments to view airspeed, altitude, and heading, then back to the front window.

The visual scan out the windows lets you look for air traffic—something that is very important in today’s crowded skies.

Occasionally, every 30 seconds or so, when you perform step 3 (look down at the control panel), also look at the engine gauges (fuel, oil, tach, and so on).

VFR and IFR Weather Restrictions

Before flying, you must make sure that you are complying with the visibility and instrument requirements for the area in which you are flying. These requirements are in the *Airman’s Information Manual* and *Federal Aviation Regulations* (FAR) books. Make sure you have the latest version because these restrictions are updated periodically.

In the lessons, you fly in *uncontrolled airspace* (the portion of airspace that has not been designated as Continental Control Area, Control Area, Control Zone, Terminal Control Area, or Transition Area) and under VFR (visual flight rule)

conditions. FAR Part 91.105, concerning basic VFR weather minimums, includes the following table:

12.3 VFR Weather Minimums

Altitude	Uncontrolled Airspace		Controlled Airspace	
	Flight visibility	Distance from Clouds	**Flight Visibility	**Distance from Clouds
1200' or less above the surface, regardless of MSL altitude	*1 statute mile	Clear of clouds	3 statute miles	500' below, 1000' above, 2000' horizontal
More than 1200' above the surface, but less than 10,000' MSL	1 statute mile	500' below, 1000' above, 2000' horizontal	3 statute miles	500' below, 1000' above, 2000' horizontal
More than 1200' above the surface, and at or above 10,000' MSL	5 statute miles	1000' below, 1000' above, 1 statute mile horizontal	5 statute miles	1000' below, 1000' above, 1 statute mile horizontal

*Helicopters may operate with less than 1 mile visibility, outside controlled airspace at 1200 feet or less above the surface, provided they are operated at a speed that allows the pilot adequate opportunity to see any air traffic or obstructions in time to avoid collisions.

**In addition, when operating within a control zone beneath a ceiling, the ceiling must not be less than 1000'. If the pilot intends to land or takeoff or enter a traffic pattern within a control zone, the ground visibility must be at least 3 miles at that airport. If the ground visibility is not reported at the airport, 3 miles flight visibility is required. (FAR 91.105)

Flight Simulator's weather for the flight lessons meets all these minimums; so as long as you stay 500 feet below, 1000 feet above, and 2000 feet horizontally away from any clouds, you are within VFR minimums.

Cruising Altitudes

If you're flying cross-country, or flying any non-maneuver situation, you should fly at designated flight levels. VFR air traffic going east (0 to 179 degrees magnetic) flies at odd thousands plus 500 feet (3500, 5500, 7500, for example), and traffic going west flies at even thousands plus 500 feet (4500, 6500, 8500, for example). IFR (instrument flight rule) traffic flies even thousands east and odd thousands west (not plus 500 feet). FAR Part 91.109 and 91.121 outlines these altitudes and all the fine points and exceptions concerning them.

When the weather is very bad, flying "on instruments" (IFR) is the only way to go. The restrictions are not nearly as severe, and flying through clouds is legal, but you must have an instrument rating. Flight plan filing and traffic control requirements are much more severe.

This completes today's ground school. The topics covered above give a good flavor of the topics you would cover in a real ground school course, and present a few of the items that pilots use the most in everyday flying. Now, it's time to take some flight lessons in Flight Simulator.

13: Basic Flight Training

The Flight Simulator flight lessons in this chapter lead you through common flight procedures and maneuvers. You can follow the computerized “instructor” as the maneuver is performed, or you can fly the maneuver yourself, with feedback from the instructor. These lessons should teach you enough to fly Flight Simulator quite effectively, and will familiarize you with the maneuvers performed in flying.

The explanations that accompany the lessons and give information about the topics covered are excerpts from the *Flight Training Handbook* AC 61-21A, published by the U.S. Department of Transportation, FAA Flight Standards Service. The official handbook gives much more detail on the topics than is presented here (the handbook is over 300 pages long). You can buy a copy at an airport.

Before you fly a lesson, first read about the lesson. Then select the lesson from the Flight Instruction menu. Let the instructor fly the lesson, then fly it yourself.

Note The weather generator and dynamic scenery are turned off when you run the lessons.

Using the Flight Instruction Menu

The Flight Instruction menu lets you select a flight lesson. Activate the menu by selecting option 3, Flight Instruction, on the Mode menu.

The lessons available appear at the top of the menu. Select option W to see more lessons. Check option X, Lesson Mode, to be sure it is what you want (Instructor Control or Student Control), then select the lesson.

Instructor Control Mode

Selecting option X on the Flight Instruction menu toggles between Instructor Control and Student Control. In Instructor Control mode, the instructor flies the selected lesson. The instructor’s comments appear on the 3-D screen and highlight the important flight actions. Student mode begins automatically following the instructor’s demonstration of a lesson.

Press Esc to exit from an instructor mode flight lesson before it is finished. All other keys are locked during the lesson.

Student Control Mode

Selecting Student Control mode puts you in control. You are positioned at the beginning of the lesson (up in the air or on the ground as appropriate). Then the instructor gives you the controls. Try flying the lesson as the instructor did in Instructor Control mode. The instructor will make comments as you fly, giving you feedback on how you are doing.

Student Control mode actually analyzes your actions and gives feedback based on your actions. It does not blindly lead you through a series of mechanical motions that may or may not give you correct flight results.

Exiting from Flight Instruction

Always exit Flight Instruction by selecting option Z, End Lessons, on the Flight Instruction menu, or option 1, Normal Flight, or option 5, Entertainment, on the Mode menu. Do not select option B, Mode, on the Mode menu to resume normal flying, as this only changes your location, aircraft simulation, and control settings, but does not take you out of flight instruction.

Flight Lesson Sequencing

If you want to run the lessons one after another automatically, select option Y, Lesson Sequencing, on the Flight Instruction menu. If option X, Lesson Mode, is set to Instructor Control, the instructor flies a lesson, then you fly the lesson, one lesson after another. If option X is set to Student Control, the instructor demonstrations won't be seen; you fly the lessons one after another. To start the sequence, select the first lesson you want to fly.

Ground Operations

The first step before taking to the air is learning how to get around the airport on the ground. You should know about taxiing to the runway, moving slowly, and staying in control.

Lesson 1. Taxiing

This lesson teaches you to taxi. You will taxi down a taxiway and stop at the line before the runway. It is here that you do a final check before takeoff.

Basic Flight Maneuvers

The following lessons take you through the basic techniques of flying an aircraft.

Lesson 2. Attitude Flying

"Attitude Flying" in chapter 12, "Ground School," explained the concept of attitude flying, using visual and instrument references to orient yourself correctly as you fly. This lesson takes you through a short flight as you watch the references and perform your information scan.

Lesson 3. Straight and Level

In straight and level flight, you maintain a constant heading and altitude.

Straight flight is achieved by holding a constant heading. Select two or more outside visual references (a town or road, for example) to form an imaginary line, and keep the plane pointed along the line. While flying the line, check the heading indicator to confirm that you are flying a straight course. Compensate for slight deviations from the straight course by making very shallow turns, using the ailerons and rudder.

Level flight is achieved by holding a steady altitude, using pitch to compensate for altitude deviations, and power to control airspeed.

The pitch attitude for level flight (constant altitude) is obtained by selecting some portion of the aircraft's nose (axis indicator in Flight Simulator) and keeping it fixed relative to the horizon. Look at the altimeter occasionally to confirm that you're holding constant altitude. If you are deviating, change pitch (yoke forward or back) to return to the altitude you want.

There are two points to remember about level flight:

- The pitch required to maintain a steady altitude varies with power setting, aircraft loading, and airspeed.
- Although the vertical speed indicator shows how fast you are climbing or descending, don't try to maintain level flight by zeroing this instrument. If you "chase" the gauge, the gauge's lag and the aircraft's momentum lag can cause the altitude to oscillate, turning straight and level flight into a roller-coaster ride. Instead, use the altimeter to make slight corrections and establish a constant altitude trend. You will notice, when glancing at the vertical speed indicator, that it is hovering around zero.

Lesson 4. Turns

A turn is a basic flight maneuver used to change or return to the heading you want. It involves close coordination of all three flight controls—ailerons, rudder, and elevators.

Turns are made by banking the wings. By changing the direction of the wings' lift toward one side or the other, the airplane is pulled in that direction. This is done by applying coordinated aileron and rudder pressure to bank the airplane in the direction of the turn.

Turns are divided into three classes:

- Shallow—bank angle less than 20 degrees, with the inherent stability of the airplane acting to level the wings, unless some control force is used to maintain the bank.
- Medium—bank angle between 20 and 45 degrees, which the airplane tends to hold constant without control force on the ailerons.

- Steep—bank angle greater than 45 degrees, at which the “overbanking tendency” of the airplane overcomes stability, and the bank tends to increase unless pressure is applied to the aileron controls to prevent it.

When making a turn, the plane tends to lose altitude, because some of the lift is being used to turn the plane, reducing the lift available to hold up the plane. Compensate by pulling back on the yoke to create more lift.

This lesson takes you through a 30-degree-bank turn. Notice that you must add a bit of up elevator to maintain steady altitude and that the plane is stable in the bank. Once in the bank, the plane stays there with straight yoke until you apply aileron in the opposite direction to return to straight and level flight.

When coming out of a turn, remember to plan early. The plane is still turning when you make the transition from a turn to straight flight, so start straightening out 10 degrees early. Remember that your lift will increase as you come out of a turn. To keep from “ballooning” into the air as you straighten out, release the extra elevator that you used in the turn.

Lesson 5. Climbs

Climbs and climbing turns are basic flight maneuvers in which the pitch attitude and power result in a gain in altitude. As with other maneuvers, climbs should be performed using both flight instruments and outside visual references.

The climb is broken into three phases—entry, constant climb, and level off.

On entry, pitch the aircraft nose up, then add full power. Generally, add pitch before power to avoid increasing engine RPM above redline, caused by the lack of resistance in level flight.

After entry, you are in a constant climb at full power. You must use pitch to control your climb airspeed. Hold pitch constant and wait for airspeed to stabilize. Make slight changes in pitch until you reach the climb airspeed you want.

When climbing, you usually have some goal in mind: clearing obstacles as quickly as you can (best angle of climb), getting to a higher altitude as fast as possible (best rate of climb), or efficiency and taking it easy on the engine (cruise climb). An aircraft’s flight manual tells what these speeds are.

When nearing the target altitude, pitch downward to reduce your climb. As a general rule, start leveling off at 10% of your vertical velocity from your target altitude, in feet. For example, if you are climbing at 700 feet per minute, start leveling off at 10% of 700, or 70 feet, below your target altitude. Keep full power on until cruise speed is reached, then adjust power to control airspeed in level flight.

Lesson 6. Cruise Descents

Descents also have three phases—entry, steady descent, and level off.

On entry, reduce power, then use pitch to control vertical descent speed. Power should be reduced initially by about 500 RPM. After a descent is established, adjust power to the cruise speed you want.

Once you are in a steady descent at the airspeed and sink rate (feet per minute vertical speed) you want, keep descending until you near your target altitude. When at 10% of your vertical speed from the goal altitude, start to level off. For example, at 500 feet per minute sink rate, start to level off at 50 feet above your target altitude.

Level off by increasing throttle to cruise power. Use pitch to hold constant altitude in level flight.

Lesson 7. Slow Descents

Slow descents are used during landing approaches and should be practiced before trying to land the plane. The descent in this lesson occurs at about 70 knots.

During the slow descent, reduce power greatly. With a low power setting, your airspeed will drop dramatically. When it gets near the 70-knot goal, use pitch to control airspeed. Keep it at 70 knots using elevators. If you get too slow, put your nose down to keep up the speed. If you want to maintain a certain sink rate (1000 feet per minute, for example), use power to adjust your sink rate.

The FAA and flight instructors vary in their thinking on the “pitch/power rule,” but most instructors advise using pitch to control airspeed and power to control vertical speed (glidepath for landing).

Takeoffs and Departure Climbs

The two lessons on takeoffs teach you the basic takeoff method, and then the crosswind takeoff.

Lesson 8. Takeoff Roll

Taking off is relatively easy. You simply apply full power and the plane accelerates until it gets to flying speed (the *takeoff roll*), and then it leaves the ground (the *liftoff*). You then climb away from the runway (the *initial climb*).

Here are a few important procedures to note on takeoffs:

- Steer down the runway using rudder (aileron/rudder on Flight Simulator).
- Strive for smooth throttle operation when applying the power.
- When you reach *rotation speed* (about 80 knots), smoothly *rotate* the aircraft by pulling back on the yoke (raising elevators). Do not jerk the plane off the ground.
- Pay attention to pitch to avoid getting pitch too high and airspeed too low, which can result in a stall.

After the takeoff, you will establish a standard climb configuration.

Lesson 9. Crosswind Takeoff

Although wind compensation is considered a more advanced topic, it is covered in this basic lesson because of its importance in air traffic control. When you take off, you must stay in line with the runway to avoid drifting in the traffic pattern.

In a real aircraft, this requires independent use of the ailerons and rudder. When you activate this lesson, the ailerons and rudder will be unlinked for uncoordinated flight.

To perform a crosswind takeoff, go down the runway applying right aileron into the right crosswind (wind blowing across the runway from right to left). Steer the plane down the runway using the rudder controls.

Once you lift off, apply the ailerons and rudder into the wind until you have turned enough that your correction angle (crab angle) keeps you lined up with the runway. Look behind you to see any drifting. Then level your wings and keep on a straight course, aligned with the runway.

Landing Approaches and Landings

The toughest basic of flying is landing. There are many landing techniques (normal, short field, power approach, crosswind, and others), but the lesson in this section sticks to a simple, straight-in, normal landing under no-wind (or headwind) conditions.

Lesson 10. Final Approach, Flare, and Touchdown

The way to assure a safe, easy landing is to set up a very good approach.

You must approach the runway at the proper airspeed. If you are too fast, you will overshoot or hover above the runway for a long distance before touching down; if you are too slow, you may touch down in the field before the runway.

You must approach the runway with the proper descent angle. Long, shallow approaches with power on can be dangerous, especially if there are many ground obstacles, or you have an engine failure. Too steep an approach can make flaring difficult.

This lesson first sets up a good approach that takes you toward the runway at 70 knots with power almost cut, and flaps down. This is a “full stall” landing. During the approach, airspeed is controlled with pitch, just as in slow flight.

It takes practice to judge whether you are headed toward the runway. Landing on the first third of the runway is the goal. If it looks like you’re going to overshoot, cut power. If it looks like you’re coming in too short, add a bit of power. Never try to stretch the glide by applying back elevator pressure alone to reach the desired landing spot. This will actually shorten the gliding distance if power is not added simultaneously. Proper angle of descent and airspeed should be maintained by coordinating pitch attitude changes and power changes.

Finally, when 10 to 20 feet above the ground, the *roundout* or *flare* is started. You pull back on the stick (apply up elevator) and try to hold the wheels about one foot above the runway as the plane bleeds off speed. Try thinking about keeping the plane from landing instead of landing the plane. The plane is designed to stall onto the runway at 49 knots. This requires more and more up elevator as the plane slows, until finally it loses all lift; the elevators are so far back that the angle of attack becomes great enough to make the plane stall and touch down.

Once on the ground, use the brakes to slow to a stop.

14: Advanced Flight Training

Now it's time to go beyond the basics needed to fly the plane and learn some advanced flight techniques. These maneuvers teach you how the aircraft responds in marginal conditions. This can be important in emergency situations. To see the advanced flight lessons on the menu, select option 3, Flight Instruction, on the Mode menu, and then option W, See More Lessons, on the Flight Instruction menu.

Stalls

When a plane flies too slowly and its angle of attack to the oncoming (relative) wind gets too high, the plane stalls and loses all its lift. One wing usually stalls slightly before the other because conditions are never totally symmetrical for both wings. Losing all the lift on one wing causes the plane to bank quickly in the direction of the stalled-out wing, and can cause the plane to roll. Modern aircraft are designed with some twist in their wing, which gives the portion of the wing closest to the aircraft a higher angle of attack, thus making the wing surface near the aircraft's center stall first. This greatly reduces the rolling tendency.

Lesson 1. Full Stall—Power Off (Approach)

Power-off stalls are usually performed with normal landing approach conditions, to simulate an accidental stall during a landing approach. Before executing these stalls, it's important to go to a practice area that is clear of traffic, to look around for any air traffic that may pose a problem, and to be at an altitude high enough above ground level to assure recovery after the stall, with lots of altitude to spare.

Performing a Power-Off Stall

- 1 Put the aircraft into landing configuration and cut the power (gear and flaps are put down below 85 knots—inside the white arc on the airspeed indicator).
- 2 Apply carb heat to prevent icing.
- 3 As the plane slows down, use the elevators to hold constant altitude flight.
- 4 When approach speed is reached, put the plane into an approach attitude, as if coming in for a landing. Adjust pitch to maintain airspeed.
- 5 When the approach attitude and airspeed have stabilized, raise the nose (elevators raised) to an attitude that will induce a stall.
- 6 Maintain directional control with the rudder, and hold the wings level with the ailerons until the stall occurs. You can tell when you are in the full stall by the full up elevators, high sink rate, uncontrollable nose-down pitching, and buffeting.

Recovering from a Power-Off Stall

- 1 Reduce angle of attack by reducing elevators.
- 2 Apply full throttle slowly.
- 3 Lower the nose as necessary to regain flying speed, then return to straight and level flight. Note the altitude loss. You don't want a stall like this to happen near the ground.

Lesson 2. Full Stall—Power On (Departure)

Power-on stall recoveries are practiced from a straight climb, and a climbing turn with a 15- to 20-degree bank, to simulate an accidental stall occurring during takeoff. Power-on stalls actually occur near the ground. In an airplane, they must be practiced at an altitude of at least 3000 feet, for safety. But in Flight Simulator, you may practice power-on stalls closer to the ground, if you want.

Performing a Power-On Stall

- 1 Attain climb attitude and speed.
- 2 Raise the nose to an attitude that is obviously impossible to maintain.
- 3 Hold that attitude until a stall occurs. Full power is used during this stall.

Recovering from a Power-On Stall

- 1 Reduce angle of attack by releasing elevator back pressure.
- 2 Lower the nose to regain flying speed, and return to straight and level flight.

Lesson 3. Accelerated Maneuvering Stall

This is the final stall lesson. Gross weight and load factors influence the airspeed at which a plane will stall. At the same gross weight, configuration, and power setting, a plane always stalls at the same indicated airspeed if no acceleration is involved. Excessive maneuvering loads imposed by turns, pullups, or other abrupt flight path changes, can cause a stall. Stalls entered from such flight situations are called *accelerated maneuver stalls*, a term that has no reference to the airspeeds involved.

In this lesson, it is assumed that our aircraft has a *type certificate* of the Utility or Aerobatic category and is approved for accelerated maneuvers. The object of demonstrating this stall is to show how it can occur and how to recover from it quickly. A prolonged stall condition should never be allowed.

Performing an Accelerated Maneuvering Stall

- 1 Get into a banked turn.
- 2 Apply increasing back pressure on the elevators, which increases the centrifugal force and the wing loading.
- 3 After airspeed reaches the design *maneuvering speed* (the speed at which maneuvers that create excessive G forces could damage the aircraft's structure), increase back pressure until a stall occurs.

Recovering from an Accelerated Maneuvering Stall

- Release back pressure and increase power.

Other Advanced Instruction

The following lessons are not as dramatic as stalls, but show some advanced techniques that you will eventually need when flying.

Lesson 4. Uncoordinated Flight

An airplane is in coordinated flight when it's flying straight through the relative wind rather than slightly sideways through it. An airplane is most efficient in this attitude and is safest, too. The ball in the turn indicator (see figure 1.1) shows aircraft coordination. If it's centered, the aircraft is coordinated.

On Flight Simulator, option 5, Auto Coordination, on the Sim menu links rudder and ailerons together. When this is on, the appropriate amount of rudder for yaw and ailerons for bank is applied in turns to keep the plane coordinated. In this lesson, the link is turned off and the individual effects of the ailerons and rudder are examined. The plane is banked with the ailerons and a straight rudder, resulting in a slow, sloppy, uncoordinated turn. Then the rudder is used alone, and the airplane yaws as it drags itself around a turn with the coordination ball pushed to one side. This is known as a *skid*, and should be avoided during normal flight because it can cause an accidental spin.

Lesson 5. Slips

This lesson takes uncoordinated flight one step further, showing a good use for flying in an uncoordinated attitude—the slip. A slip is performed by putting a plane in a bank using the ailerons. The bank tends to make the plane turn, but opposite rudder is applied to keep the plane from turning. The plane ends up flying at a constant heading, but in a bank. Since the plane is banked, side forces are produced, and the plane moves to the right or left, depending on the direction of bank.

This effect is useful when landing in a crosswind, where you must keep the plane lined up with the runway, but the wind makes it necessary to add a left or right component to your speed.

When in a slip, drag is increased because the aircraft is uncoordinated, making the slip useful for slowing down a plane.

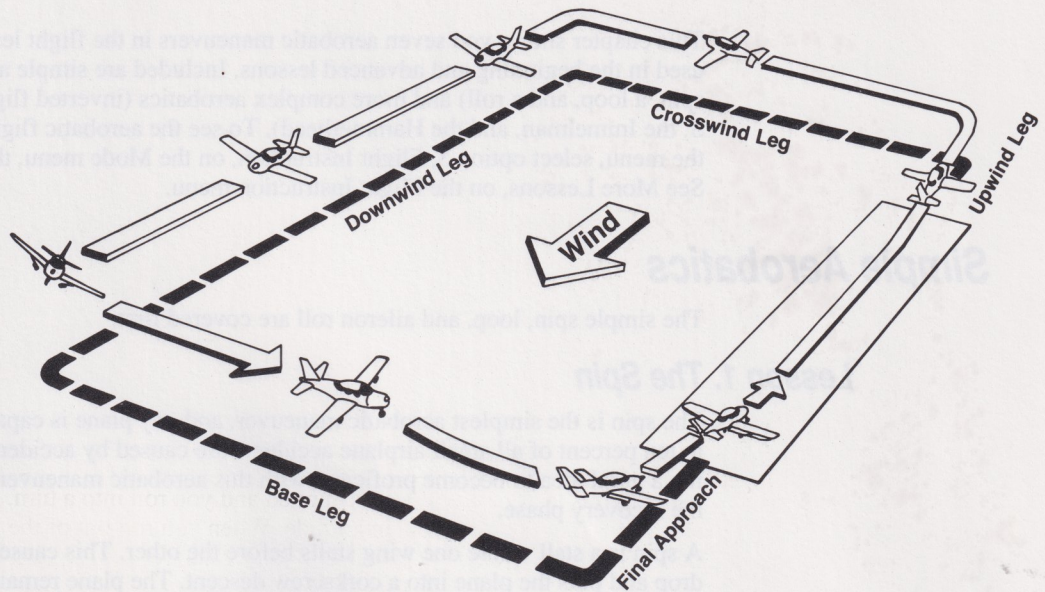
Lesson 6. Steep Turns

Steep turns of 45 to 55 degrees are quite challenging and border on the aerobatic. In this lesson, full power is applied and you roll into a turn. A lot of up elevator is required to maintain altitude. When you roll out of the turn, it's important to release up elevator. "Ballooning" out of a steep turn is a common mistake.

Lesson 7. Traffic Pattern

Figure 14.1 shows a basic rectangular traffic pattern. This left-hand (counter-clockwise) pattern assures that air traffic flows into and out of airports in an orderly manner. Traffic patterns, their direction, and their altitude are established based on local conditions. At simple airports without control towers, or unless the airport displays approved visual markings indicating that turns should be made to the right, use the standard left-hand pattern.

14.1 Basic Rectangular Traffic Pattern



Lesson 8. VOR Tracking with Wind

Chapter 16, "Navigation Course," explains VOR use. It's important to see it in action, however.

In this lesson, you tune in a VOR station on the NAV 1 radio and center the OBI needle. You fly a course to the VOR and notice the DME distance to station changing. The needle starts to drift due to the wind. Center the needle, but this time compensate for the wind by heading into it a bit. The needle now stays centered as you fly directly toward the station with the corrected heading.

15: Aerobatics Course

This chapter shows you seven aerobatic maneuvers in the flight lesson fashion used in the beginning and advanced lessons. Included are simple aerobatics (a spin, a loop, and a roll) and more complex aerobatics (inverted flight, the split S, the Immelman, and the Hammerhead). To see the aerobatic flight lessons on the menu, select option 3, Flight Instruction, on the Mode menu, then option W, See More Lessons, on the Flight Instruction menu.

Simple Aerobatics

The simple spin, loop, and aileron roll are covered first.

Lesson 1. The Spin

The spin is the simplest aerobatic maneuver, and any plane is capable of it. Five to ten percent of all small airplane accidents are caused by accidental spins, so it's a good idea to become proficient with this aerobatic maneuver, especially the recovery phase.

A spin is a stall where one wing stalls before the other. This causes one wing to drop and puts the plane into a corkscrew descent. The plane remains in the spin until the pilot moves the controls and stops it. Figure 15.1 shows the spin.

Select option J, The Spin, on the Flight Instruction menu, watch the instructor fly one, and then try one yourself.

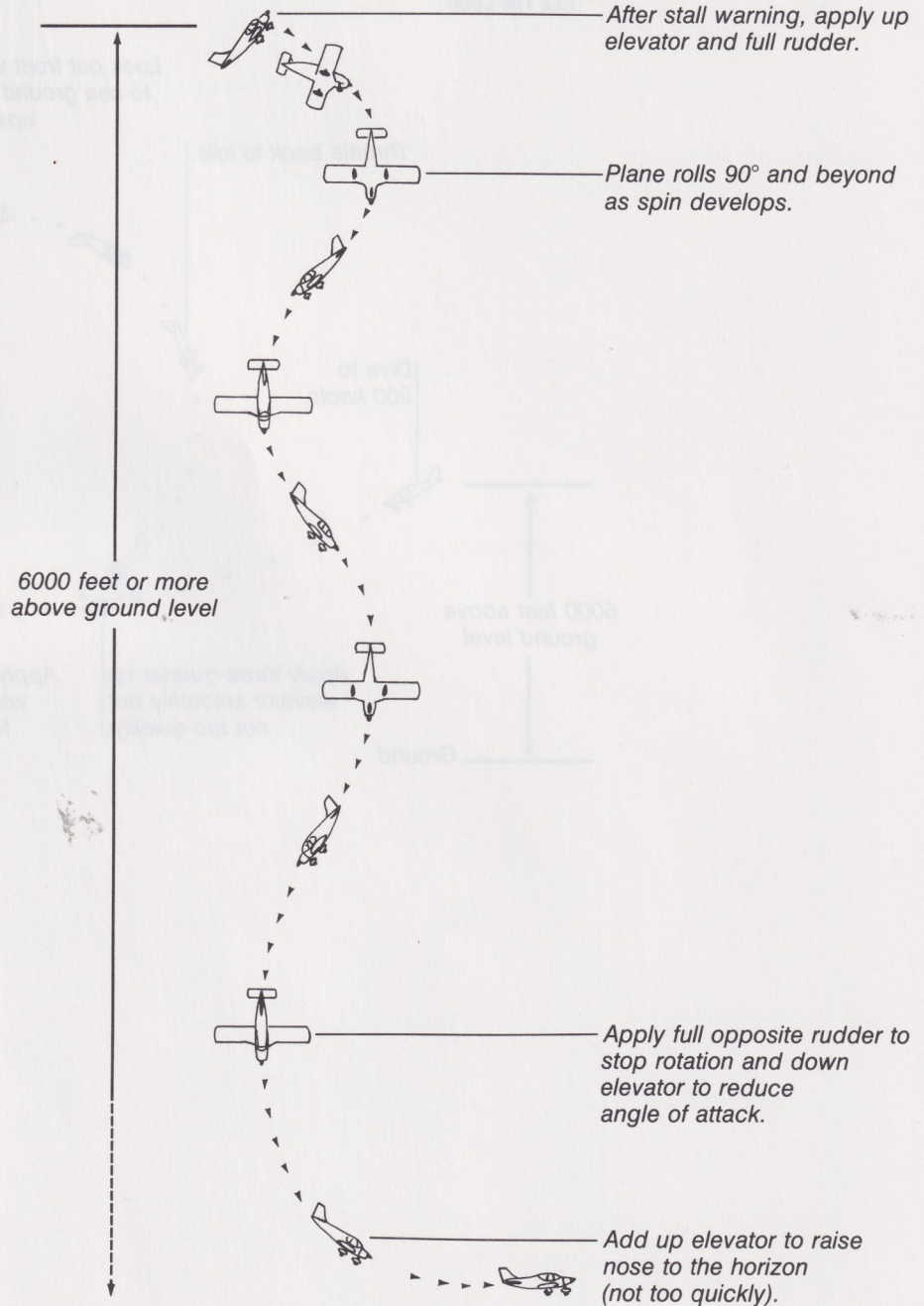
Making a Spin

- 1 Put Flight Simulator in Uncoordinated Flight mode and climb to 6000 feet above ground level (AGL).
- 2 In cruising flight (no flaps), bring the throttle back to idle power.
- 3 Use the elevators to raise the nose slowly to a point slightly above the horizon.
- 4 Hold this attitude until the stall warning sounds.
- 5 Apply additional up elevator and full rudder left or right, to spin left or right, respectively.
- 6 The plane will roll to a 90-degree bank and beyond as the spin develops.

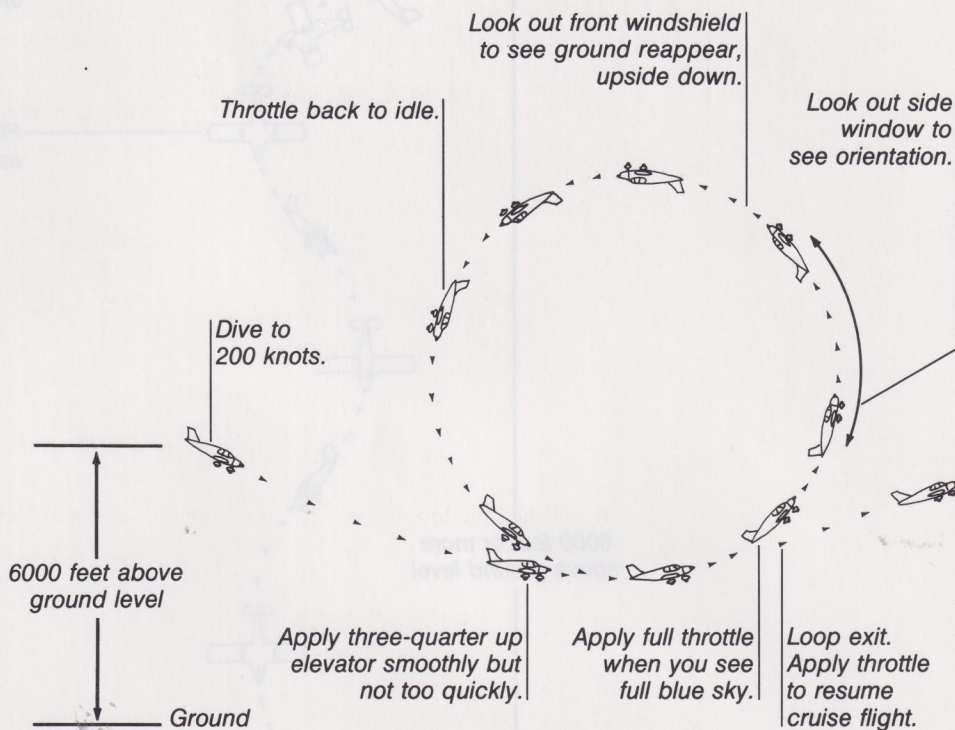
Recovering from a Spin

- 1 Recover from the stall by using full opposite rudder to stop rotation.
- 2 Apply down elevator to reduce your angle of attack.
- 3 Complete recovery by applying up elevator to raise the nose to the horizon, being careful not to apply elevator too quickly, risking another stall.

15.1 The Spin



15.2 The Loop



Lesson 2. The Loop

This is the second-easiest aerobatic maneuver. You use elevators and throttle to pitch the plane through 360 degrees, flying a vertical circle in the sky. The key to a successful loop is to obtain enough airspeed to allow the plane to fly through the complete circle without stalling. Figure 15.2 shows the loop.

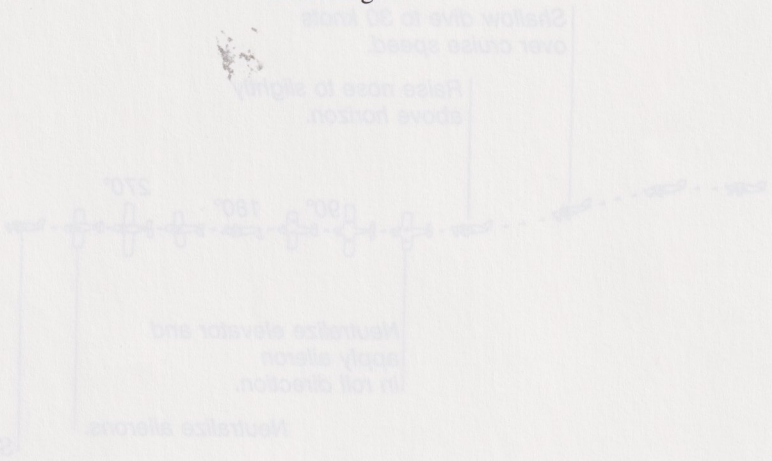
Select option K, The Loop, on the Flight Instruction menu, watch the instructor fly one, and then try one yourself.

Making a Loop

- 1 Put Flight Simulator in Auto-coordinated Flight mode and climb to 6000 feet AGL.
- 2 Get into normal cruise flight, with flaps up at normal cruise throttle.
- 3 Use down elevator to dive rapidly until airspeed reaches about 200 knots.
- 4 Apply up elevator smoothly, not too rapidly, until about three-fourths up.
- 5 After the nose rises and you see blue sky through your windshield, apply full throttle. Look at a side view to see your pitch orientation.
- 6 When the loop is nearly half complete, switch to forward view and watch the earth reappear upside down.
- 7 When the loop is three-fourths complete, bring the throttle back to near idle, to avoid over-revving your engine as you dive.

Recovering from a Loop

- As you come out of the loop, level off, apply throttle, and resume normal cruise flight.



Lesson 3. Aileron Rolls

In this maneuver, the ailerons are used to roll the plane through 360 degrees of bank. This maneuver is fairly simple because your plane is capable of very rapid roll rates. One of the most difficult aspects of the aileron roll is getting your plane to stop rolling at the proper time. Figure 15.3 shows an aileron roll.

Select option L, Aileron Rolls, on the Flight Instruction menu, watch the instructor fly one, and then try one yourself.

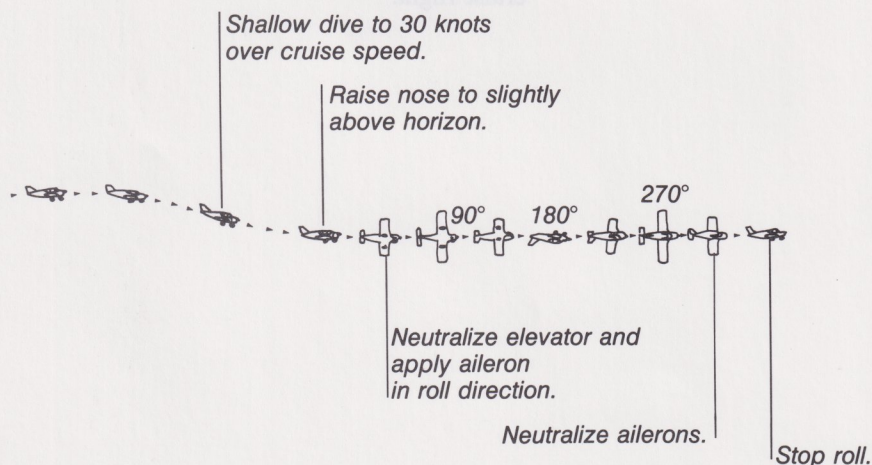
Making an Aileron Roll

- 1 In Uncoordinated Flight mode, get into cruise configuration and begin a shallow dive to pick up 30 knots over cruise speed.
- 2 Use the elevators to raise the nose to point slightly above the horizon.
- 3 Neutralize the elevators and apply left or right aileron, depending on which direction you want to roll.
- 4 The plane will roll past vertical (90-degree bank), upside down (180 degrees), vertical again (270 degrees), and then roll toward level.

Recovering from an Aileron Roll

- 1 Begin to neutralize ailerons shortly before you are level again.
- 2 If properly timed, you will be near level attitude when the roll stops. Resume cruise flight.

15.3 Aileron Roll



Complex Aerobatics

The following aerobatic maneuvers are more complex than the first three and require more concentration and control to perform correctly.

Lesson 4. Inverted Flight

Inverted, or upside down, flight is quite disorienting. This maneuver is an extension of the aileron roll, but you must begin neutralizing your ailerons as the plane rolls past vertical to stop the roll as the plane turns upside down.

At this point, the horizon and artificial horizon will be upside down. The elevators work backward. Pushing forward “drops” the nose toward the sky, but the ailerons work as usual. If you start losing altitude while upside down, remember to push the nose down (down elevator).

Come out of inverted flight by completing the last half of your aileron roll. Figure 15.4 shows inverted flight.

Select option M, Inverted Flight, on the Flight Instruction menu, watch the instructor fly one, and then try one yourself.

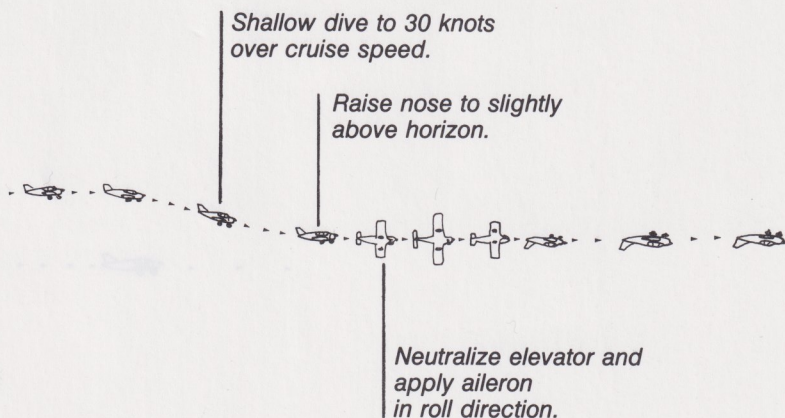
Flying Inverted

- 1 Begin an aileron roll.
- 2 Begin neutralizing your ailerons shortly after rolling past 90 degrees to stop the roll so the plane is upside down.
- 3 Use reverse elevator to control pitch and establish level, inverted flight.

Recovering from Inverted Flight

- Apply aileron to complete the last half of the aileron roll.

15.4 Inverted Flight



Lesson 5. Split S

This maneuver is actually an alternate way of coming out of inverted flight. Instead of completing the aileron roll, you pull back on the elevators, close the throttle, and do the last half of a loop. Figure 15.5 shows a split S.

Select option N, Split S, on the Flight Instruction menu, watch the instructor fly one, and then try one yourself.

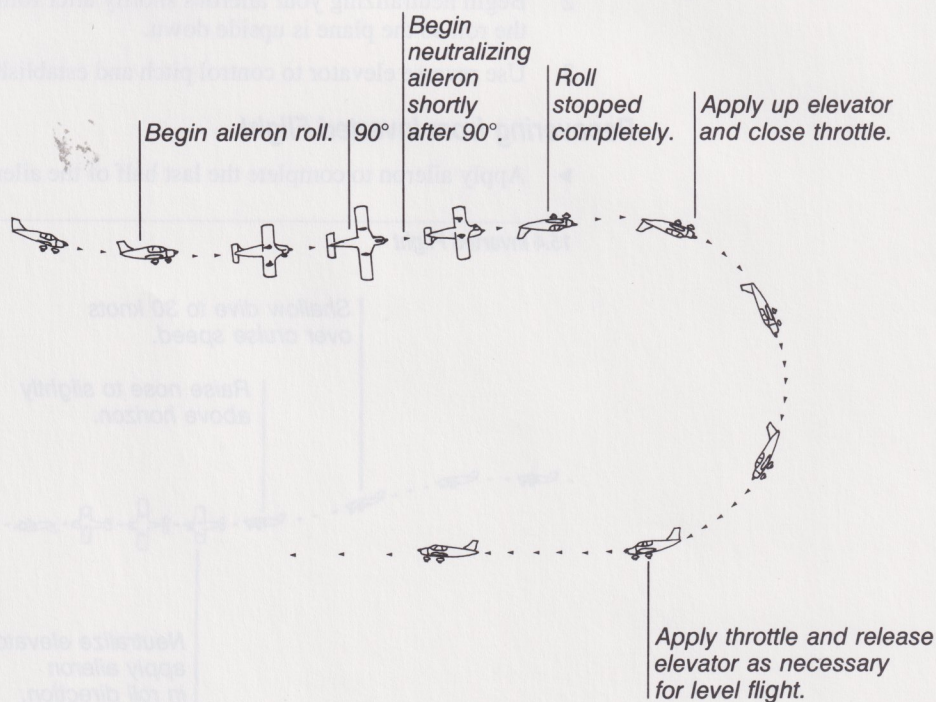
Flying a Split S

- 1 Begin an aileron roll.
- 2 Begin neutralizing your ailerons shortly after rolling past 90 degrees to stop the roll so the plane is upside down.
- 3 Once in inverted flight, apply up elevator and close the throttle to do the last half of a loop.

Recovering from a Split S

- As you come out of the loop, level off, apply throttle, and resume normal cruise flight.

15.5 The Split S



Lesson 6. Immelman

This maneuver was invented by a German ace, Max Immelman, and was used as a tactical maneuver to evade other aircraft in a dogfight. The Immelman is a half loop followed by a half roll (as opposed to the split S, which is a half roll followed by a half loop). Figure 15.6 shows an Immelman.

Select option O, Immelman, on the Flight Instruction menu, watch the instructor fly one, and then try one yourself.

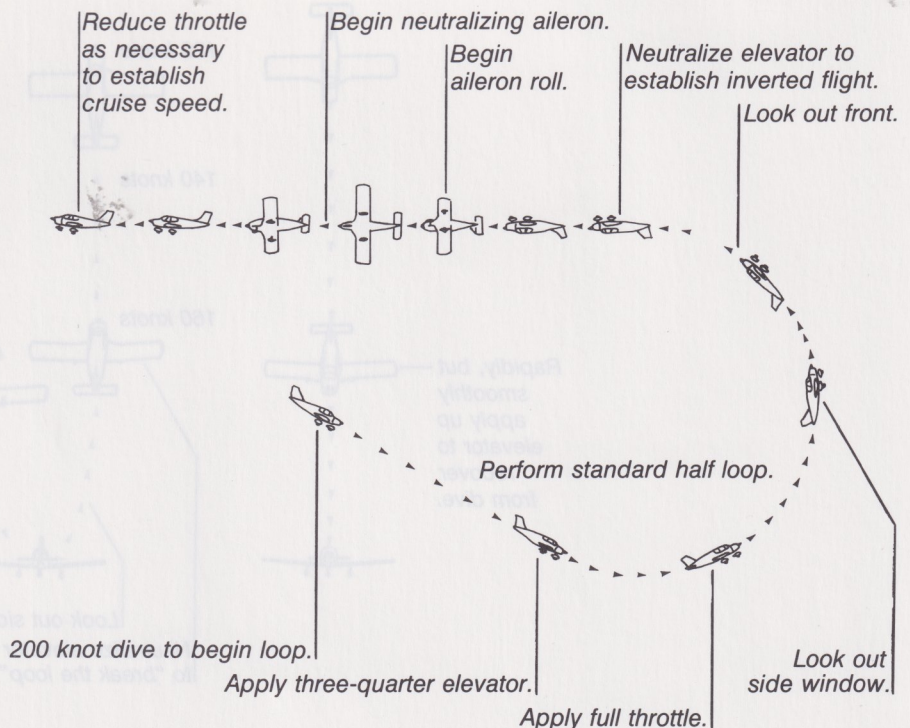
Flying an Immelman

- 1 Position the plane as described in the Loop.
- 2 Note your heading and begin the loop.
- 3 Neutralize elevators the moment the plane becomes exactly inverted at the top of the loop. This stops the plane in inverted flight at a relatively slow airspeed.
- 4 Follow through with a half roll to level off on top.

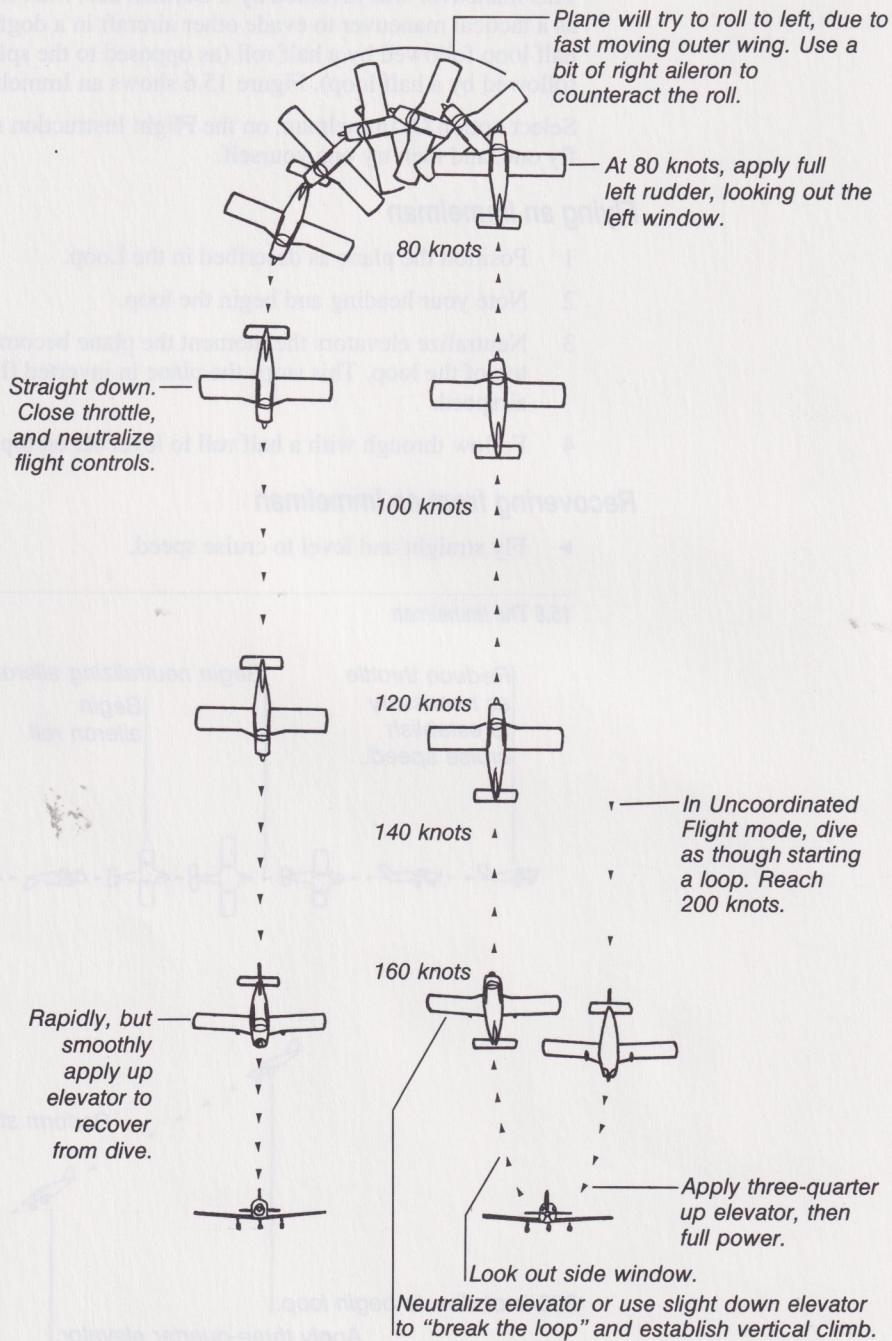
Recovering from an Immelman

- Fly straight and level to cruise speed.

15.6 The Immelman



15.7 The Hammerhead



Lesson 7. Hammerhead

The final aerobatic maneuver is the Hammerhead turn or Hammerhead stall. It is often referred to as a wingover, since that describes what the plane does, but this term also describes other less difficult maneuvers. Uncoordinated Flight mode is used to perform this maneuver. Figure 15.7 shows the Hammerhead.

Select option P, Hammerhead, on the Flight Instruction menu, watch the instructor fly one, and then try one yourself.

Flying a Hammerhead

- 1 Put Flight Simulator into Uncoordinated Flight mode and dive as though starting a loop.
- 2 Apply three-quarter up elevator and full throttle for a vertical climb.
- 3 Look out of the side window. Just as the bottom of the wing comes up, perpendicular to the horizon, neutralize the elevators or apply slight down elevator. You are now in a vertical climb.
- 4 When airspeed drops to about 80 knots, leave the elevators unchanged and apply full left or right rudder, looking out of the left or right window respectively.
- 5 As the plane yaws at the top of the Hammerhead, the fast-moving outer wing develops more lift and tends to make you roll. Carefully use a bit of opposite aileron to counteract this roll. This takes a lot of practice.
- 6 Once the nose has yawed 180 degrees to straight down, close the throttle, neutralize all flight controls, then rapidly but smoothly apply up elevator to recover from vertical dive back to level flight.

Recovering from a Hammerhead

- 1 Turn to the proper heading, because this maneuver changes your heading by 180 degrees.
- 2 Resume cruise flight.

16: Navigation Course

This chapter explains how to use the instruments and visual cues to navigate the plane cross-country and under conditions in which you cannot see ground references, such as flying above the clouds. For information about the location of the navigation instruments and how to set them, see chapter 1, “Basic Window Display and Flight Instruments.”

In this chapter, you also learn about the EFIS/CFPD display, which is the wave of the future in aircraft navigation and control.

Pilotage

Flying cross-country from one visible landmark to another, using only a flight chart, is called *pilotage*. This method requires that the flight be made at fairly low altitudes so you can easily identify landmarks. Pilotage cannot be used in areas that lack adequate landmarks or when visibility is low.

Pilotage is easy to perform and does not require special equipment. It's frequently impractical, however, because you often fly a zig-zag course between landmarks, resulting in a longer flight.

Dead Reckoning

Dead reckoning is the navigation of an airplane solely by computations based on airspeed, course, heading, wind direction and speed, ground speed, and elapsed time. You point the plane in the direction of your destination (plus a correction factor for wind), and fly at a known speed for the amount of time it takes to cover the distance.

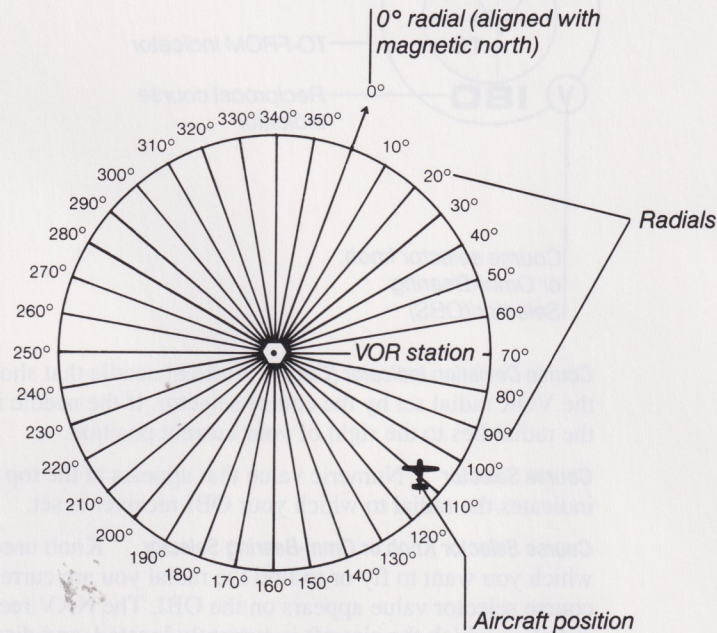
Dead reckoning is seldom used alone because even the slightest deviation in course could place you miles from your target destination.

The most common form of VFR navigation is a combination of dead reckoning and pilotage—flying in a computed direction, correcting for errors using landmarks that come into view along the way. There may be stretches where no landmarks are seen for miles, but dead reckoning over these miles keeps the plane well enough on course, and avoids the zig-zagging of pure pilotage.

VOR Navigation

VORs are radio stations that transmit an omnidirectional identification signal followed by a circular sweeping directional signal. The NAV receiver in the aircraft decodes these signals to determine the angle or radial from the station you are on. You can think of radials as directional beams radiating outward from the VOR station like the spokes of a wheel (see figure 16.1).

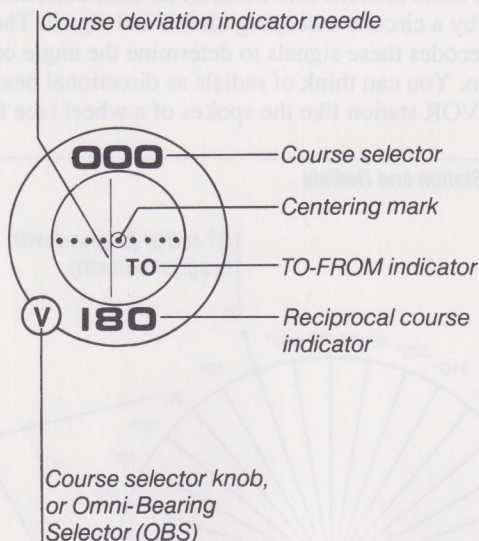
16.1 VOR Station and Radials



The Omni-Bearing Indicator (OBI) is used to determine what VOR radial your plane is on, and helps you fly along radials toward or away from the VOR station.

As shown in figure 16.2, the OBI consists of the course deviation indicator (CDI), course selector, course selector knob or Omni-Bearing Selector, and the TO-FROM indicator.

16.2 VOR Indicator



Course Deviation Indicator (CDI) Vertical needle that shows your deviation from the VOR radial set by the course selector. If the needle is to the right of center, the radial lies to the right of your current position.

Course Selector Numeric value that appears at the top of the OBI. This number indicates the radial to which your OBI receiver is set.

Course Selector Knob or Omni-Bearing Selector Knob used to select the radial on which you want to fly or to find the radial you are currently intercepting. The course selector value appears on the OBI. The NAV receiver interprets the radial on which the aircraft is currently located, and displays the relationship between this and the selected course on the OBI. The current radial may be "read out" by turning the course selector knob until the CDI needle is centered and by observing the TO-FROM indicator to resolve any ambiguity. To turn the course selector knob, press V, followed by 1 or 2, then the plus key or minus key on the main keyboard to increase or decrease the setting, or click the right or left side of the digits with the mouse.

TO-FROM Indicator Indicator showing whether you are on the radial shown by the course selector or on the radial 180 degrees away from it. When the TO indicator is displayed, the CDI shows course deviation as described above if you are flying toward the VOR station. When the FROM indicator is displayed, the CDI works as outlined above if you are flying away from the VOR station. You can fly toward a VOR station with a FROM indication, or away from a VOR with a TO indication, but the CDI will work backwards.

OBI Readings

OBI readings indicate your aircraft's position relative to the VOR station radial. The aircraft's heading has no effect on the OBI reading. You can, however, use the course selector to estimate the heading you must fly on to remain aligned with the radial.

Since the OBI reading is independent of the aircraft's heading, you can fly along a selected radial and the OBI indicator will indicate valid course deviations in either flight direction. If the TO-FROM indicator reads FROM, the course selector's course is approximately the heading you should fly. If the TO-FROM indicator says TO, then the reciprocal course, as indicated by the digits displayed at the bottom of the OBI, is the approximate heading. On windy days, you will have to compensate for any crosswinds that may blow you off your radial by increasing or decreasing your heading.

The TO-FROM indicator prevents disorientation. You can, if you wish, fly toward a VOR station on the FROM radial and, as long as the CDI needle is centered, you will stay on course. However, the course deviation noted on the indicator will be backward. If the needle is to the right of center, you will have to fly to the left to intercept the radial again. Avoid this confusion by always flying on the FROM radial when headed away from the station, and on the TO radial when headed toward the station.

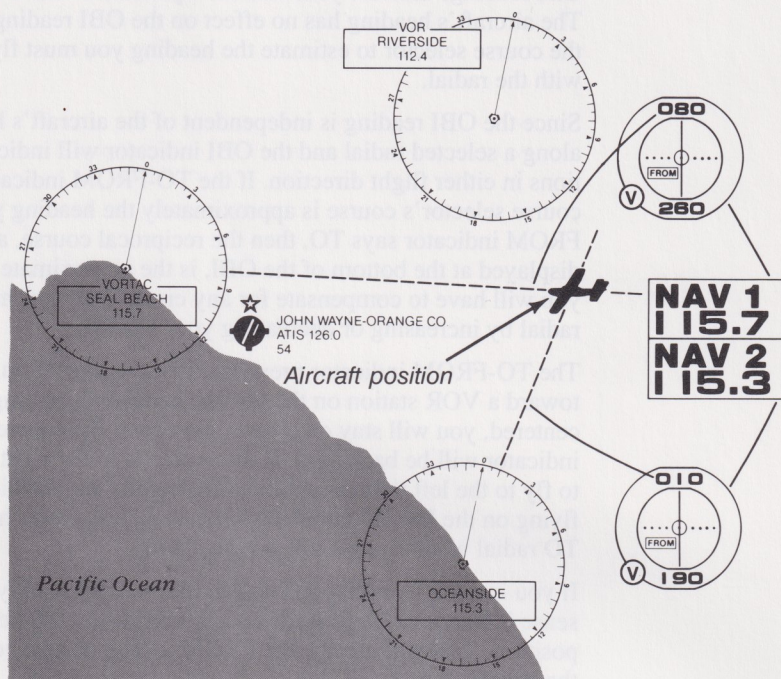
If you intercept a radial and decide to fly along it, only to find that the needle sense is backward, adjust the course selector to 180 degrees from its current position. This will change the FROM to TO, or vice versa, and will reorient the needle.

Uses and Advantages of Two NAV Radios

Two NAV radios and corresponding OBIs are provided to allow you to tune in two VORs simultaneously. There are several advantages to using two NAV radios.

- You can identify your exact position by tuning in two VORs and finding the radial you are currently intercepting for each VOR. The point where the two radials intersect (cross) is your position. Figure 16.3 shows this technique.

16.3 Using Two VORs to Identify Position



When determining your position using radial intercepts, you must be careful that you are on the radial shown by the course selector and not on the one 180 degrees away from it. It is possible to center the needle at two course selector settings; one on the radial you are really on, with FROM showing on the TO-FROM indicator, and the other one on the radial 180 degrees away, with TO showing. Make sure FROM is displayed, and then read the radial on the course selector. If TO is displayed, change the course selector so that FROM is displayed.

- Two NAV radios can also be used to determine flight progress while flying toward a VOR. If you are flying toward a VOR tuned in on NAV 1, you can set NAV 2 to another VOR and set its OBI to a radial you will be crossing on your flight path. When you cross this preselected checkpoint, the VOR needle for NAV 2 swings past center.
- With two NAV radios, you can rapidly switch from one radio to the other (on which you have your VOR frequency and heading already adjusted) when air traffic control tells you to immediately take up a course toward the VOR station.
- A second radio can serve as a backup if the other fails.

Distance Measuring Equipment (DME)

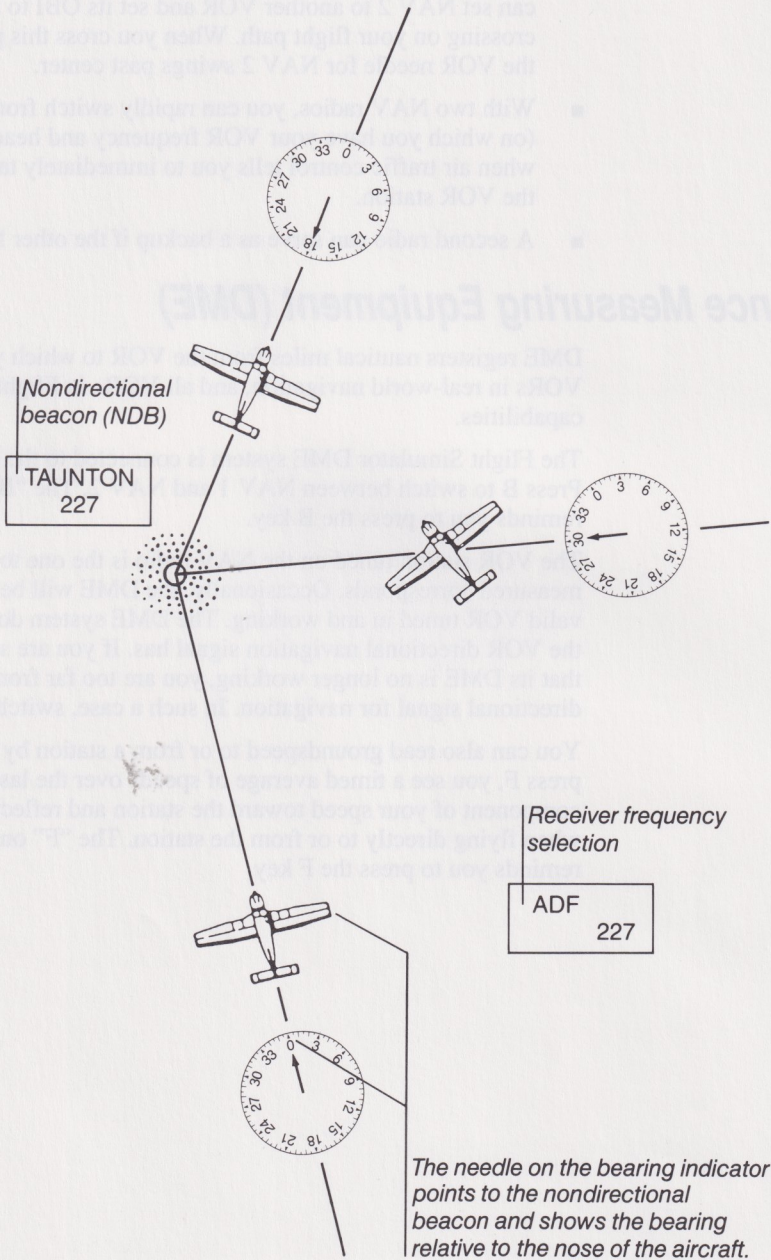
DME registers nautical miles from the VOR to which you are tuned. Most VORs in real-world navigation, and all VORs in Flight Simulator, have DME capabilities.

The Flight Simulator DME system is connected to the NAV 1 or NAV 2 radio. Press B to switch between NAV 1 and NAV 2. The “B” on the DME indicator reminds you to press the B key.

The VOR station tuned on the NAV radio is the one to which the distance measured corresponds. Occasionally, the DME will be blank when you have a valid VOR tuned in and working. The DME system does not have the range that the VOR directional navigation signal has. If you are so far away from a VOR that its DME is no longer working, you are too far from the VOR to rely on its directional signal for navigation. In such a case, switch to a new VOR.

You can also read groundspeed to or from a station by pressing F. When you press F, you see a timed average of speeds over the last few minutes. This is the component of your speed toward the station and reflects ground speed only when flying directly to or from the station. The “F” on the DME indicator reminds you to press the F key.

16.4 Automatic Direction Finder



Automatic Direction Finder (ADF)

The Automatic Direction Finder (ADF) is used with nondirectional radio beacons (NDBs). When the ADF receiver is tuned to an NDB, the needle on the bearing indicator (see figure 16.4) points to the station, and shows the bearing relative to the nose of the aircraft (the relative bearing). The magnetic bearing to the station can be calculated by adding the relative bearing to the aircraft's magnetic heading.

Instrument Landing System (ILS)

The Instrument Landing System (ILS) is a set of navigation systems that direct you to a runway for a safe landing in nearly any kind of visibility conditions. The four main systems involved are:

- **Localizer**—a sort of VOR that can be used on only one radial that is lined up with the runway. You tune it in on your NAV radio like a normal VOR station, but you don't set the OBI to a radial direction, because the direction is set automatically. Needle movement is four times as sensitive as a normal VOR station, so you can hold your horizontal course very precisely.
- **Glideslope**—a sort of VOR turned in an up/down direction. The glideslope needle on OBI 1 is used to track the glideslope. This instrument, like the localizer, is very sensitive, and deflects from needle up to needle down in 1.4-degree glideslope variation.
- **VHF Marker Beacons**—beacons placed on the ground directly below the localizer path at preset distances. They transmit a very tight radio beam, straight up, so the OMI (outer, middle, and inner) marker-light receiver on the plane picks them up when you fly directly over the beacons. This gives you information about the distance to the runway. The marker beacons emit tones related to each marker in the form of dots (short tones) and dashes (long tones) in a unique sequence:

Marker	Tones
Outer Marker	Repeating dashes
Middle Marker	Alternating sequence of dots and dashes
Inner Marker	Repeating sequence of dots

- **Approach lights**—normally installed on the ILS runway to provide for transition from instrument to visual flight.

This instrument system lets you make a precision approach by tracking the localizer and glideslope down to the runway. The approach is precise enough in most cases, given good approach lighting and a lack of obstacles, to guide you down to a decision height of 200 feet AGL, one-half mile short of the runway.

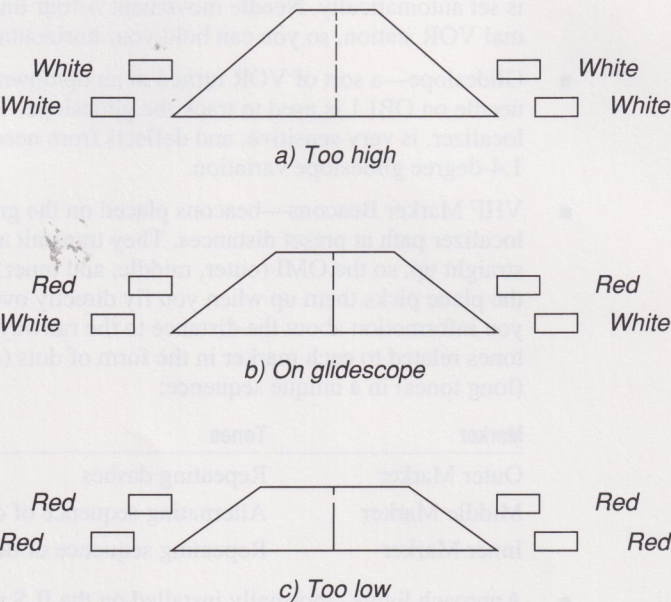
Approach Lighting Systems

Approach lighting systems are visual aids that give you guidance information while you make an approach to a runway. They help you stay lined up horizontally with the runway and help guide you down the proper glideslope. These aids are on miscellaneous runways throughout Flight Simulator, but the runway 32 approach at Champaign has all aids and is a good place to practice.

Visual Approach Slope Indicator

The Visual Approach Slope Indicator (VASI) uses color-coded lights positioned along the runway near the touchdown point, and acts as a visual glideslope indicator. As you fly toward the runway on your final approach, the lights show different colors if you are above, below, or on the correct glideslope. Figure 16.5 shows the color codes used to indicate proper glideslope.

16.5 Glideslope Indicators



VASI can be found at Meigs field and Champaign.

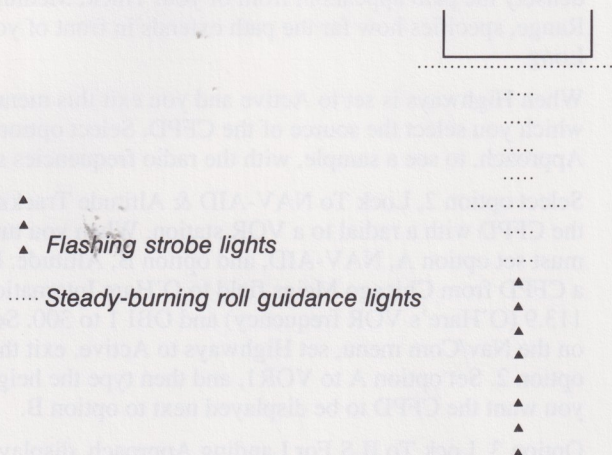
Runway End Identifier Lights

Runway End Identifier Lights (REIL) are two synchronized flashing lights located laterally on both sides of the runway threshold facing the approach area. They help identify runways that could be confused with surrounding terrain or city lights, and also help highlight the runway under conditions of reduced visibility.

Medium Intensity Approach Lighting System

Flight Simulator includes a Medium Intensity Approach Lighting System with RAIL (Runway Alignment Indicator Lights). The MALSR is one member of a family of approach lighting systems that provide both horizontal and glideslope information. A row of flashing strobe lights lined up with the runway cycle toward the runway at two cycles per second. In operation, the strobes resemble tracer shells being fired at the runway. A row of roll guidance bars is sometimes included. Figure 16.6 shows one MALSR approach lighting system.

16.6 MALSR



MALSR can be found at San Francisco International, Oakland International, Los Angeles International, John F. Kennedy International, and Champaign.

Airport Beacons

You can spot airports at night by their flashing beacons. Beacons alternate between green and white. Locations of beacons are shown on the charts at the back of this manual.

EFIS/CFPD Display

Electronic Flight Instrument Systems (EFIS) are the wave of the future in aircraft navigation and control. These systems encompass everything from engine controls and checklists on CRT displays in cockpits to advanced heads-up displays (HUDs) that display symbology and instrumentation on the pilot's windshield. EFIS systems are usually microcomputer-driven.

One of the most promising new EFIS systems is the Command Flight Path Display (CFPD). CFPD is a navigation aid that projects a flight path on the pilot's windshield. The best way to describe it is as a "highway in the sky." A series of horizontal rectangular plates is laid out in front of you. The path follows the flight path or instrument approach you are supposed to fly.

Flight Simulator includes several variations of the CFPD. To try it, select option 8, EFIS/CFPD Display, on the Nav/Com menu.

Set option 1, Highways, to Active to start the system. The other options on the menu are used to control the path. Option 2, Type, specifies the type of path: Rectangles (you fly through them), "Yellow Brick Road" (you fly down them like driving down a road), or Telephone Poles. Option 3, Density, specifies how densely the path appears in front of you: Thick, Medium, or Thin. Option 4, Range, specifies how far the path extends in front of you: Short, Medium, or Long.

When Highways is set to Active and you exit this menu, a new menu appears in which you select the source of the CFPD. Select option 1, Fly A Sample CFPD Approach, to see a sample, with the radio frequencies set for you.

Select option 2, Lock To NAV-AID & Altitude Tracking, if you want to align the CFPD with a radial to a VOR station. When you turn on option 2, you also must set option A, NAV-AID, and option B, Altitude. For example, to generate a CFPD from Chicago Meigs field to O'Hare International, you set NAV 1 to 113.9 (O'Hare's VOR frequency) and OBI 1 to 300. Select EFIS/CFPD Display on the Nav/Com menu, set Highways to Active, exit the menu, and then turn on option 2. Set option A to VOR1, and then type the height above the ground that you want the CFPD to be displayed next to option B.

Option 3, Lock To ILS For Landing Approach, displays a CFPD that brings you to the runway, if you set NAV 1 to the ILS frequency for the airport to which you are heading.

Be sure option 4, Initialize On Exit, is turned on (has a plus next to it) before you exit the menu.

Turn on option 5, Plot Intercepting Path, if you want an intercepting path between your current position and the main CFPD you have requested.

17: Flight Analysis and Course Plotting

This chapter describes the flight analysis system that helps you improve your landings and maneuvers, and the course plotting system that lets you plot and review your course. Flight Simulator also analyzes your crashes to help you determine what went wrong with your flight.

Flight Analysis

When flying a plane through landings and maneuvers, you get a general idea of your actions, but it's hard to tell your exact flight path. Flight analysis is designed to give you feedback concerning your flight path after maneuvers are performed. You can see how round your loops were, how good your flare was, or what your flight path was during a stall.

Landing Analysis

Landing analysis evaluates your landing. It monitors a landing from the time you are 100 feet above the runway. After your landing, a graph shows:

- Your flight path to the runway
- Your vertical velocity when you touched down

Activating Landing Analysis

- 1 Set up a landing approach. It can be straight in or in a pattern. You must be more than 100 feet above the runway.
- 2 On the Mode menu, select option 2, Flight Analysis.
- 3 Select option 1, Landing Analysis, on the Flight Analysis menu.
- 4 Make the landing. When you roll to a stop, the analysis graph appears.
- 5 Press Esc to continue with normal flight.

Maneuver Analysis

Maneuver analysis is similar to landing analysis, but it is not triggered by the 100-foot rule. Course recording begins the moment you leave the Flight Analysis menu and ends when you press Backslash.

Activating Maneuver Analysis

- 1 Set up for a maneuver.
- 2 On the Mode menu, select option 2, Flight Analysis.
- 3 Select option 3, Maneuver Analysis, on the Flight Analysis menu.

- 4 Perform the maneuver.
- 5 Press Backslash when the maneuver is finished. The analysis graph appears.
- 6 Press Esc to continue with normal flight.

Crash Analysis

In addition to analyzing landings and maneuvers, Flight Simulator can analyze your crashes. To activate crash analysis, select Detect And Analyze for option 2, Crash, on the Sim menu. When you crash, a graph showing flight trajectory, vertical velocity, and other information appears. Use this graph to determine what went wrong in the flight and how to correct it. Press Esc to erase the graph and reset the simulator.

Course Plotting

The course plotting system lets you record your course and display it against the scenery over which you have flown. In Course Recording mode, the aircraft's three-dimensional position is recorded at preset intervals. In Course Display mode, red (or white on a monochrome monitor) line segments are drawn between these points. You can record and display at the same time, if you want.

Plotting Your Course

- 1 On the Mode menu, select option 2, Flight Analysis.
- 2 Select option 2, Course Plotting, on the Flight Analysis menu.
- 3 Turn on option 1, Recording, to begin plotting your course.
- 4 Option 2, Resolution, specifies how often samples are taken and how fast the recording buffer is filled up. The buffer size is limited; it starts erasing the oldest part of your course plot if it runs out of buffer space.

If you plan on flying cross-country, set Resolution to Coarse.

If you are doing a precision maneuver, set Resolution to Fine. Use fine resolution mode for skywriting.

- 5 To erase old plot information in the buffer and start a fresh smoke trail, select option 5, Clear Course Buffer.

Reviewing Your Course

Turn on option 3, Display, on the Course Plotting menu to begin reviewing your course. When this is on, you see a projection of the course plot. Whatever is currently in the course buffer is displayed.

Entertainment

18: Formation Flying and Crop Dusting	130
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Entertainment

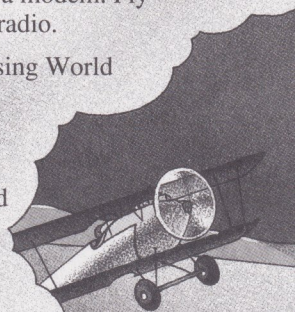
When you get past all the practical aspects of flying, most pilots will tell you that flying is just plain fun. Air races, fly-ins, airshows, and skywriting are all events that give flying a unique aviation community spirit. With that spirit in mind, Flight Simulator includes this entertainment section that lets you participate in flying for the fun of it.

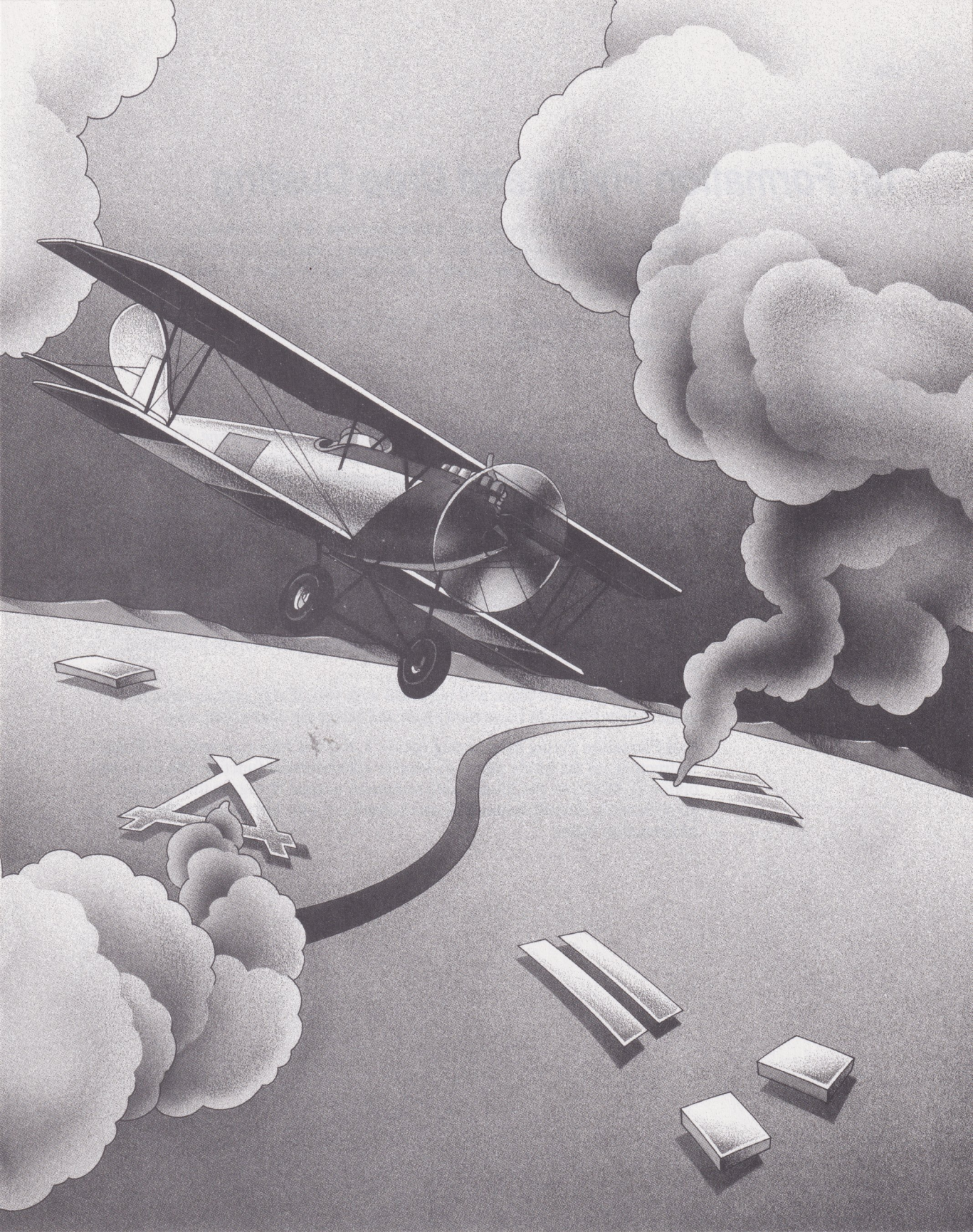
Chapter 18, "Formation Flying and Crop Dusting," describes two games included in Flight Simulator.

Chapter 19, "Multi-Player Flight," is similar to formation flying, but the other aircraft has a real pilot behind it—a friend at the other end of a modem. Fly with a friend and send messages back and forth on the COM radio.

Chapter 20, "World War I Ace," is a classic dogfight game using World War I biplanes.

You can run the entertainment functions using any plane. Formation Flying and Crop Duster are designed to be used with the Cessna; the World War I game is designed to be used with the Sopwith Camel. Results with other planes may be less than optimal, but Flight Simulator does allow you to fly any aircraft in any environment.





18: Formation Flying and Crop Dusting

This chapter describes two of the games included in Flight Simulator. Formation Flying lets you fly with a computer-controlled aircraft through a series of obstacles and maneuvers. Following the other plane's smoke trail is a real challenge.

Crop Duster is a game in which you try to completely cover a field using a minimum amount of spray.

Formation Flying

Flight Simulator is even more fun when flying with another plane. Keeping the plane in sight and following it through maneuvers is quite challenging, and the visual effects can be impressive, especially against a scenic backdrop.

To begin formation flying, select option 5, Entertainment, on the Mode menu, then option 2, Flying In Formation, on the Entertainment menu.

The Formation Flying menu lists seven startup situations. These situations include flying through a city by weaving around buildings, and following the lead plane under a series of bridges and over the tops of buildings. The lead plane leaves a smoke trail and is always quite easy to find. If you get too far behind the lead plane, press Spacebar to move your plane closer to the lead plane.

If you crash, the lead plane will not crash with you. If you want to rerun the game, select Flying In Formation again and select the course you want.

Exit Formation Flying by selecting option 1, Normal Flight, or option 3, Flight Instruction, on the Mode menu, or another entertainment function. Do not select option B, Mode, on the Mode menu to resume normal flying, as this changes your location, aircraft simulation, and control settings, but does not take you out of formation flying.

Crop Duster

In this game, you are flying a crop-dusting plane. The smoke system is now a spray system. You turn the spray on and off with the I key.

To begin crop dusting, select option 5, Entertainment, on the Mode menu, then option 3, Crop Duster, on the Entertainment menu.

The goal is to spray the rectangular field, avoiding obstacles at the end of the field, to get maximum coverage. Make sure to turn the spray off at the end of the field. You will have a better score if spray is on only while spraying the field.

The spray drops on the field so you can see your spray coverage. When you finish spraying, press Esc, or land the plane. You are scored on coverage, quantity of overspray, and how much time you took.

Exit Crop Duster by selecting option 1, Normal Flight, or option 3, Flight Instruction, on the Mode menu, or another entertainment function. Do not select option B, Mode, on the Mode menu to resume normal flying, as this changes your location, aircraft simulation, and control settings, but does not take you out of crop dusting.

19: Multi-Player Flight

The Multi-Player option on the Entertainment menu enables two or more players, using separate machines, to fly together. Communication between machines is through the COM (serial) port (select com 1, 2, 3, or 4).

Connecting Two Machines Together

You can connect two machines together directly if they are in the same room, or through the phone line using modems if they are in separate locations.

Direct Cable Connections

If you want to communicate between two computers in the same room, connect the computers using a null modem cable. Plug the DB25 ends (rectangular ends) of the cable into the appropriate ports on both machines.

Establishing Communications

- 1 Select option 5, Entertainment, on the Mode menu, then option 1, Multi-Player, on the Entertainment menu.
- 2 Select option A, Com Port, to select the communications port.
- 3 Select option B, Baud, to select the baud rate. It is best to communicate at the highest baud rate the machines support, so that response is quick.
- 4 Select option 1, On-line, to begin communications. This tells Flight Simulator to begin sending information, such as coordinates, between the machines.

Modem Connection

If you want to use two modems for communication, use a standard modem cable to connect a modem directly to the COM port of each computer. You do not need a null modem cable.

Making the Telephone Connection Using Hayes-Compatible Modems

- 1 Select option 5, Entertainment, on the Mode menu, then option 1, Multi-Player, on the Entertainment menu.
- 2 Select option A, Com Port, to select the communications port.
- 3 Select option B, Baud, to select the baud rate. You will probably want to use 300, 1200, or 2400 baud, depending on the baud rate your modem can handle. The other player must communicate at the same baud rate.

Now one of you must make the phone call and the other must answer it.

- 4 The person answering turns on option 5, Wait For Ring, and waits for the phone call to come through.
The caller selects option 4, Dial, and then types the phone number in the message box that appears at the bottom of the screen. Note the < symbol to the left of the message line. This means that the characters typed on that line are sent to the modem, not to the other player. Press Enter to make the phone call.
- 5 When a connection has been established, the message Connect appears on the bottom line of the message box. The computers are now ready to communicate.
- 6 Both players select option 1, On-line, to begin communications. This tells Flight Simulator to begin sending information, such as coordinates, between machines. It also disables the modem echo feature that displayed the Connect message in step 5.

Making the Telephone Connection Using Other Modems

If you are not using a Hayes-compatible modem, option 4, Dial, and option 5, Wait For Ring, may not work for you. Use the following steps to make the connection:

- 1 Select option 5, Entertainment, on the Mode menu, then option 1, Multi-Player, on the Entertainment menu.
- 2 Select option A, Com Port, to select the communications port.
- 3 Select option B, Baud, to select the baud rate. You will probably want to use 300, 1200, or 2400 baud, depending on the baud rate your modem can handle. The other player must communicate at the same baud rate.

Now one of you must make the phone call and the other must answer it.

- 4 The caller selects option 3, Messages/Talk To Modem. To talk to the modem, type < followed by the characters you want to send, and then press Enter. All characters typed on that line are sent to the modem and not to the other player. You are also removed from on-line mode so that information, such as coordinates, is not sent.

Incoming characters are echoed to the bottom line of the message box, so that you know what your modem is saying. Consult your modem documentation to see how to establish a phone connection between machines.

- 5 Once the connection is made, both players select option 1, On-line, to begin multi-player communication.

At any time, you can send a command to the modem by selecting option 3, Messages/Talk To Modem, on the Multi-Player menu, and typing < as the first character. This instructs Flight Simulator to send the line to the modem, and not to the other player. Remember that it also removes you from on-line mode, so you must select option 1, On-line, to return to multi-player communications.

When you are talking to your modem, all incoming characters are echoed to the bottom line of your message box. Any information the other player sends also appears there. It might appear as garbage. This does not mean that anything is wrong.

Flying Together

Once you have established communications, you are ready to begin multi-player flight. Place your planes so that they are visible to each other. The north and east coordinates of the other player's plane appear next to Other Plane North and Other Plane East. You can set your own coordinates to these values, or near these values, using option A, Position Set, on the Nav/Com menu.

Although you have been receiving coordinate information and see a plane representing the other player, this may not be the model the other player is flying. Select option 2, Send Aircraft, to send the model of your plane to the other player, and have the other player do the same for you.

Note If the other player is running Flight Simulator 3.0 and you are flying the Cessna 182 or an experimental prop or jet, do not select option 2 to send your model to the other player. The model information is too large for version 3.0 to handle.

Now you should be able to find the other plane. The easiest way to do this is to use the multi-player Track option. In multi-player mode, Track mode tracks the other player's plane from your aircraft, instead of tracking your plane from a movable tower. This is very useful for finding the other plane when you think it is near you but you aren't sure where to look.

Select Track mode by pressing the S key to cycle through the view modes. Your view direction might change, and the other airplane should be visible. If it's very small, zoom in for a closer look.

This track feature can be used at any time in multi-player flight to find the location of the other plane, but if you are flying your plane while in Track mode, be careful; your view might not be the view straight out of the cockpit!

Other than the difference in Track mode, all features are available and function the same in multi-player flight as in normal flight.

The Multi-Player menu includes option 6, Change Color Of Other Plane, to change the other player's airplane fuselage color. The new fuselage color is visible to you immediately if you look at the other airplane. If the other player is flying an experimental aircraft, you cannot change the airplane's color.

If you raise or lower your landing gear, this information is automatically sent to the other player, just as your coordinates are constantly being sent.

Before you exit, if your connection is through a modem, you might want to disconnect the phone by sending a message to the modem using option 3, Messages/Talk To Modem.

Exit Multi-Player mode by selecting option 8, Quit Multi-Player, on the Multi-Player menu, or by selecting option 1, Normal Flight, or option 3, Flight Instruction, on the Mode menu, or by selecting another entertainment function. Do not select option B, Mode, on the Mode menu to resume normal flying, as this changes your location, aircraft simulation, and control settings, but does not take you out of multi-player flight.

Sending and Receiving Messages

You can send messages to the other player by selecting option 3, Messages/Talk To Modem, on the Multi-Player menu. When you do so, a cursor appears in the message box at the bottom of the screen where you type the text to be sent to the other player. When the cursor appears, all characters typed are directed to the message box, and do not have any effect on your flight, such as changing the view.

You can switch from entering message text to controlling your airplane by pressing Enter, and then Spacebar. When you are flying you can return to message mode by pressing the zero (0) key. The cursor and message box reappear, and keypresses are directed to the message box.

To send your message, press Enter. The message is sent to the other player, and the top line of the message box is cleared. You can type another message if you like, or press Esc to return to controlling your airplane.

If you are typing a very long message, it will be sent in pieces as you overrun the message box.

Messages received from the other player are displayed on the bottom line of the message box. If you receive a message from the other player when your message box is not active, your message box appears automatically for you. If you want to respond to the message, do so in the normal way, or press Esc to close the box after reading the message.

Suggestions for Multi-Player Flight

Because an airplane is relatively small, and the field of view is only a small portion of 3-D space, it may be difficult at first to find and keep track of the other player's plane. This becomes easier with practice. In the meantime, here are some features that can make it easier.

- The most useful feature for keeping track of the other player's plane is the multi-player Track mode. This always points your view in the direction of the other player's plane. Observing the scenery behind the other plane can help you determine where the other plane is located in respect to your aircraft. If another 3-D window is active and is showing the view from your cockpit, it will not be too difficult to fly toward the other plane when it gets far out of range. Exciting views can be generated in Track mode when flying by and around the other plane.

- Another useful feature for keeping track of the other player's plane is the ADF gauge. If you display the ADF gauge and set it to 000, its needle will point to the location of the other plane. For example, if the other plane was to your right, the needle would point to the 9 on the ADF. The ADF can also be used with the DME to indicate the other plane's location and distance from your plane. For example, if you set the ADF to 001, and the other plane is on your right, the needle on the ADF gauge will point to the 9 and the DME will indicate the other plane's distance from you.
- It is helpful to agree to fly within a relatively small area with recognizable landmarks. For example, the Chicago database contains the John Hancock Building and the Sears Tower, two large buildings that are easy to locate from the air. If flying is kept within this area, it will always be easy to find the other plane, particularly by using these landmarks as a guide. To help the other player find you, you can send messages telling where you are and what you're doing. The map display can be helpful in locating landmarks if you get too far away from the other plane.
- One problem in finding the other plane is that it could be in any direction or at any altitude. By having both players enable autopilot and set altitude lock to the same level, the autopilot will do a good job of maintaining a fairly steady altitude, as long as you don't get too aerobatic. Then you can concentrate on looking left and right to find the other player. It can also be useful to bank fairly hard, fly in a circle, and look for the other plane to come into view. Zooming way out on the cockpit view can also be helpful.
- Slew mode and Position Set on the Nav/Com menu can help you bring your planes together, both initially and when they stray too far apart. If you get too far ahead of the other player, pause (P) your simulation for a bit to let the other player catch up. You might also want to disable crash detection, because it is easy to get so wrapped up in searching for your partner that you forget about the location of your own aircraft. With crash detection off, you can "bounce" and take off again.

Once you are adept at finding each other in a local area, it shouldn't be too hard to stay in contact in a wide open area on a cross-country flight. The view direction keys can be used to keep the other plane in sight, much as a passenger on a plane would turn to view the scenery. And watching the other plane do aerobatics can be particularly enjoyable—a sort of do-it-yourself airshow!

20: World War I Ace

World War I Ace is a three-dimensional battle game that lets you test your flying skills against those of your computer-controlled enemy. When you play, you go on several bombing runs and engage in numerous dogfights with your enemy. Your goal is to down five enemy aircraft to become a World War I ace.

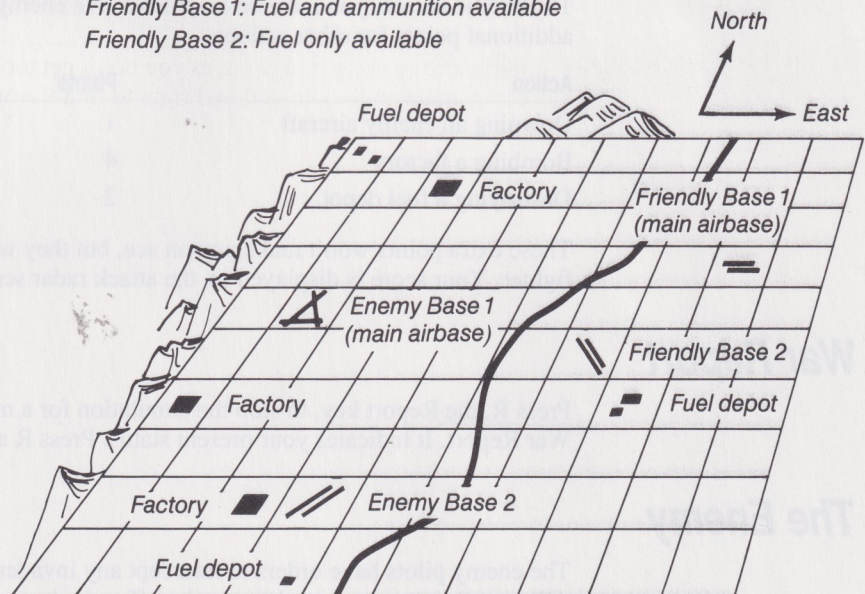
Beginning the Game

Select option 5, Entertainment, on the Mode menu, and then option 5, World War I Ace, on the Entertainment menu to begin your first game. Figure 20.1 shows the battleground. When the game starts, you are positioned on the runway of Friendly Base 1. This is your main airbase. You are fueled, armed, and ready for takeoff.

20.1 World War I Ace Battleground

Friendly Base 1: Fuel and ammunition available

Friendly Base 2: Fuel only available



Declaring War

A truce is in effect when you begin the game. The battle will not begin until you declare war by pressing W, the War key.

The enemy occupies the territory west of the river. They have established two airbases, a fuel depot for each, and several factories. Six enemy fighters stand ready to protect the fuel depots and the factories. It is your mission to shoot down as many of the enemy fighters as possible and bomb the depots and factories.

To locate your targets, you have to use the view direction keys. The downward view includes a bombsight. The bombsight helps direct you over your target so you have a better chance of scoring a hit. Press X to release one bomb. Press Spacebar to fire machine guns.

Becoming an Ace

To become an ace, you must down at least five enemy aircraft. You can earn additional points for other actions.

Action	Points
Downing an enemy aircraft	1
Bombing a factory	4
Destroying a fuel depot	2

These extra points won't make you an ace, but they will indicate your skill as a fighter. Your score is displayed on the attack radar screen.

War Report

Press R, the Report key, to stop the simulation for a moment and display the War Report. It indicates your present status. Press R again to return to the game.

The Enemy

The enemy pilots have orders to intercept any invader. However, each pilot has different instructions for when to take off and when to return to base. The skills of your opponents vary. The enemy aces are proficient and score quickly. Their lesser-skilled compatriots are less likely to hit you.

The enemy flies a wide variety of fighter aircraft. Their fleet contains two planes that are fast and rugged, but equipped with unreliable guns; one plane that is fast and easily maneuvered; one that is a fair fighter, capable of medium-range speed, maneuvered fairly easily, and equipped with average guns; and two super fighters. Be assured that the enemy aces are in the best planes.

Radar and Instruments

Although World War I aircraft were not equipped with radar, it is implemented in the game. This compensates for the viewing limitations of the 3-D screen.

An attack radar screen automatically appears in the window above the instrument panel. The attack radar screen displays your score, as well as various messages about war occurrences. It also has a bomb indicator, showing your bomb supply, and an ammunition indicator, showing your ammunition supply. The radar has a radius of approximately one mile and displays the enemy positions when the forward view is selected. Enemy aircraft are represented by dots on the screen. The small plane in the center of the radar screen shows your position and orientation.

When you play World War I Ace, the regular instrument panel is augmented with fighter aircraft instrumentation. The mouse or joysticks can be used to control the yoke, flaps, rudder, and throttle in the same manner as in normal flight mode.

Strategy and Tactics

First, scout the enemy's territory. Decide where you want to be when the battle begins. You do not have to be at your airbase to declare war. In fact, you will probably find it to your advantage to begin elsewhere.

After you declare war, watch the radar screen and look out the windshield for the enemy's approach. Move as close to an enemy plane as possible and fire by repeatedly pressing Spacebar. You have a better than average chance of hitting your enemy if the enemy is anywhere on the screen and within range of your gun. Your gun has excellent straight range, but poor side range. You must be very close to a plane to hit it when it moves to the sides of the screen.

You, too, are open for attack. Although the enemy can and will shoot you down, every firing does not register a hit for them. Each enemy pilot's success depends on his skill level. Every hit the enemy scores reduces the efficiency of your plane. If you are hit and your aircraft has been damaged (if it is acting strangely, losing fuel, or dropping oil pressure), return to base for repairs and refueling.

Refueling at Friendly Base 1 automatically replenishes your bomb supply. You can carry only five bombs at a time, so you can destroy a maximum of five targets (fuel depots and factories) per mission. Friendly Base 2 has fuel only, so any time you need more bombs you must return to Friendly Base 1.

Six enemy fighters patrol the skies above the enemy airbases. Their location varies from game to game and during the game. Damaged enemy planes are replaced while you refuel and repair your plane.

Now that you know the rules, declare war. Good luck!

Ending the Game

Exit World War I Ace by choosing option 1, Normal Flying, or option 3, Flight Instruction, on the Mode menu, or another entertainment function. Do not select option B, Mode, on the Mode menu to resume normal flying, as this changes your location, aircraft simulation, and control settings, but does not take you out of the game.

World War I Ace Control Summary

To	Press
Declare war	W
Drop bomb	X
Display war report	R
Fire machine guns	Spacebar

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Reference to Flight Simulator

This part of the manual includes the airport directory and airport runway maps, performance specifications for the planes, information about setting up a mouse and joysticks, and a keyboard summary.

Appendix A, "Airport Directory," lists all the airports in Flight Simulator and includes the information you need to use these airports.

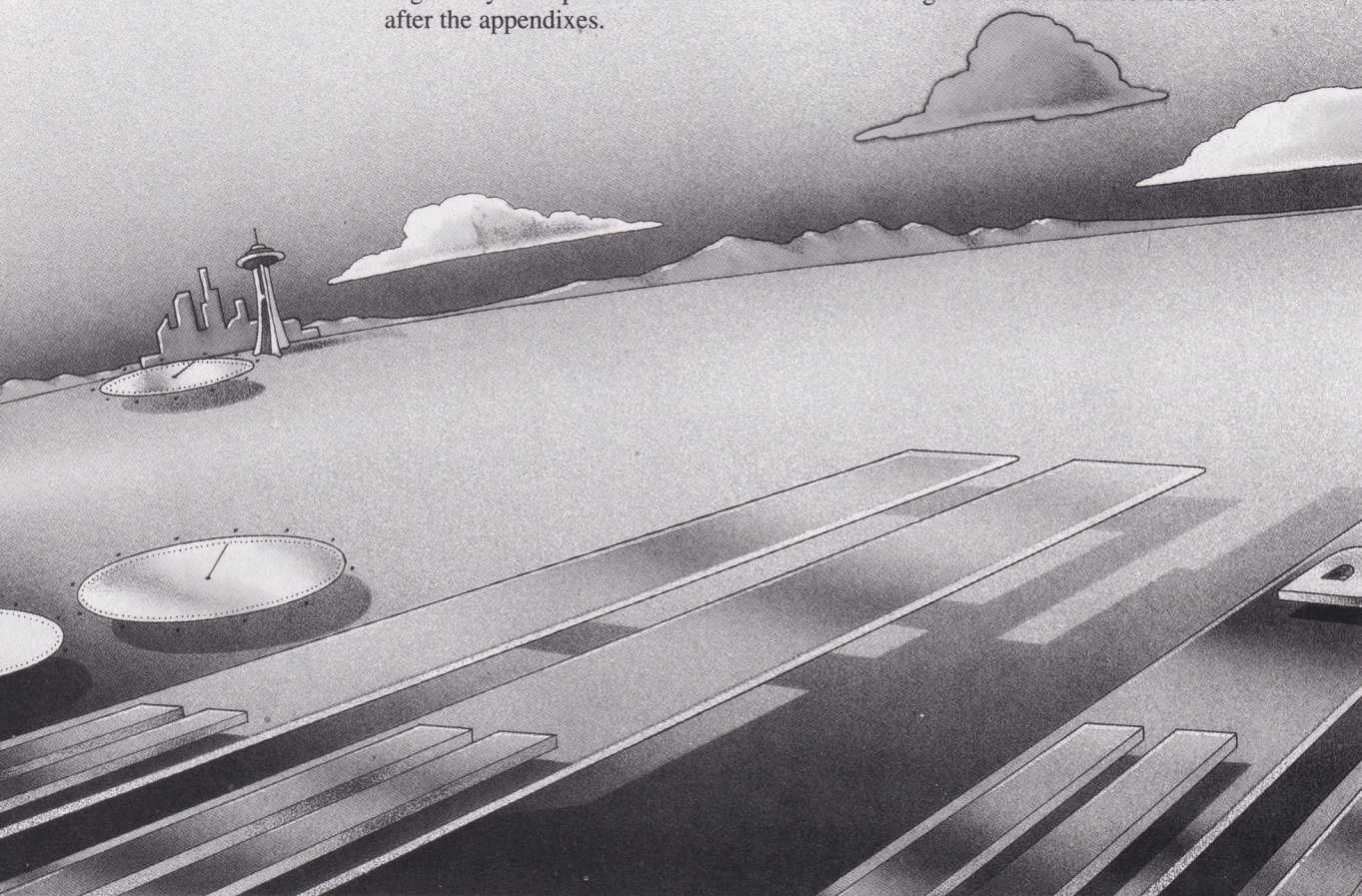
Appendix B, "Airport Runway Maps," includes maps for some airports in Flight Simulator.

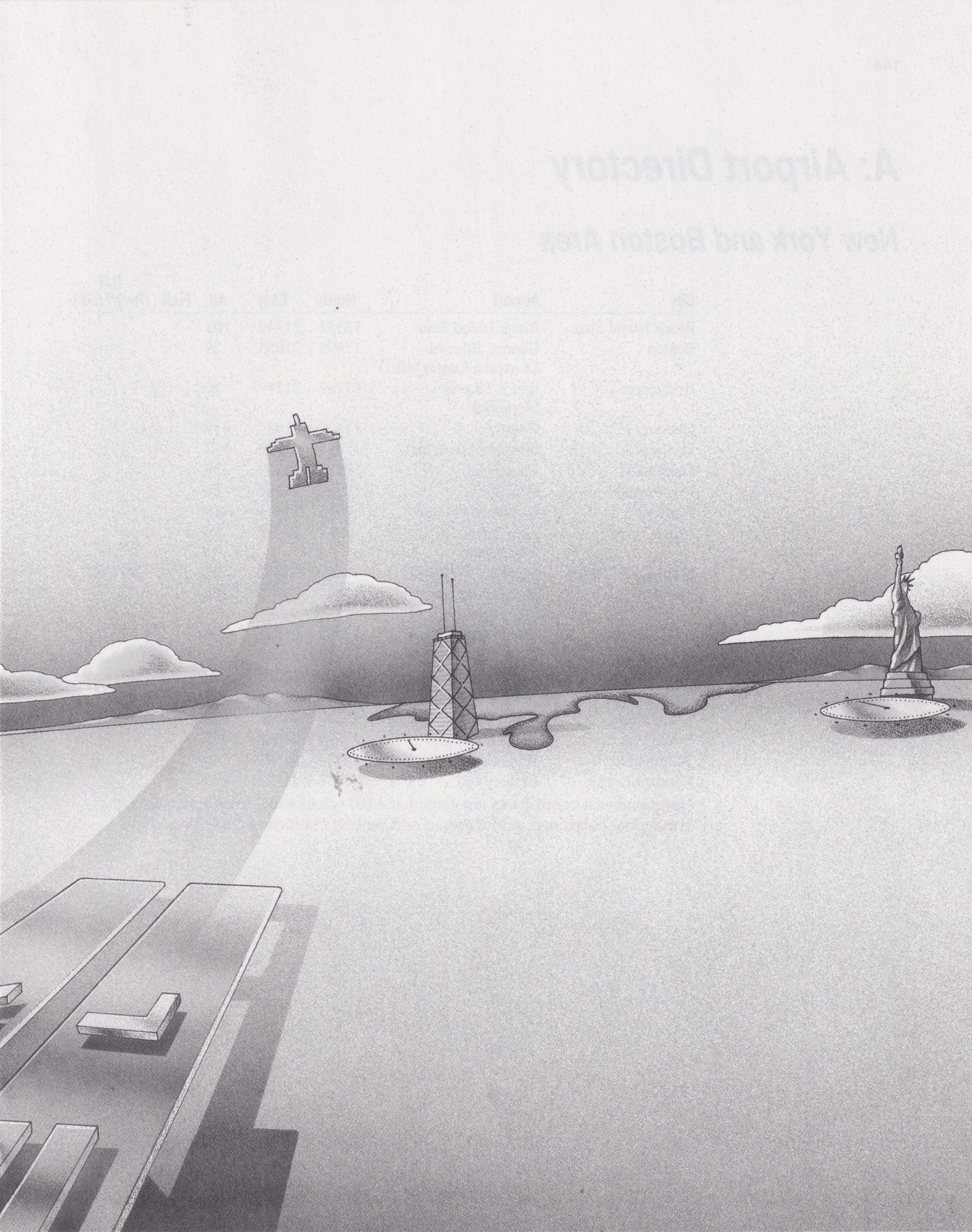
Appendix C, "Performance Specifications," gives you the technical information for the Cessna Skylane RG II, the Gates Learjet 25G, and the Schweizer 2-32 Sailplane.

Appendix D, "Using a Mouse and Joysticks," includes instructions for setting up a mouse and joysticks, plus information about use, calibration, and sensitivity controls.

Appendix E, "Keyboard Summary," is a list of all keyboard functions used to control your aircraft.

A glossary of important words or terms used throughout this manual is included after the appendixes.





A: Airport Directory

New York and Boston Area

City	Airport	North	East	Alt.	Fuel	ILS
						(Rwy/Freq.)
Block Island State	Block Island State	17352	21749	105	*	
Boston	General Edward Lawrence Logan Intl.	17899	21853	20	*	
Bridgeport	Igor I. Sikorsky Memorial	17287	21249	10	*	
Chester	Chester	17404	21434	416		
Danbury	Danbury Municipal	17360	21120	457		
Danielson	Danielson	17617	21607	239		
Farmingdale	Republic	17089	21177	81		
Hartford	Hartford-Brainard	17551	21371	19		
Islip	Long Island MacArthur	17132	21278	99		
Martha's Vineyard	Martha's Vineyard	17490	22043	68	*	24/108.7
Meriden	Meriden Markham Municipal	17447	21327	102		
New Haven	Tweed-New Haven	17339	21322	13		
New York	John F. Kennedy Intl.	17034	21065	12	*	
New York	LaGuardia	17091	21026	22		
Oxford	Waterbury-Oxford	17422	21229	727		
Southbridge	Southbridge Municipal	17733	21543	697		
White Plains	Westchester Co.	17226	21065	439		
Willimantic	Windham	17573	21521	246		
Windsor Locks	Bradley Intl.	17638	21351	174		

North and east coordinates are canted at +10° (clockwise) to compensate for orthogonal coordinate grid overlaid on Lambert conformal conic projection.

Chicago Area

City	Airport	North	East	Alt.	Fuel	ILS
						(Rwy/Freq.)
Aurora	Aurora Municipal	17152	16393	706		
Bloomington	Bloomington-Normal	16593	16246	875		
Champaign (Urbana)	University of Illinois, Willard	16400	16465	754	*	32L/109.1
Chicago	Chicago-Midway	17156	16628	619	*	
Chicago	Chicago-O'Hare Intl.	17243	16578	667	*	4L/111.3 4R/110.1 9L/110.5 9R/111.1 14L/110.9 14R/109.7 22L/110.1 22R/111.3 27L/111.1 27R/110.5 32L/109.1 32R/110.7
Chicago	Lansing Municipal	17052	16697	614		
Chicago	Merrill C. Meigs	17189	16671	592	*	
Chicago/Blue Island	Howel	17100	16627	600		
Chicago/ Schaumburg Air	Schaumburg Air Park	17247	16515	795		
Chicago (West Chicago)	DuPage	17213	16466	757		
Danville	Vermilion Co.	16471	16685	695		
Dwight	Dwight	16874	16404	630		
Frankfort	Frankfort	17025	16596	775		
Gibson City	Gibson City Municipal	16594	16461	759		
Joliet	Joliet Park District	17038	16490	582		
Kankakee	Greater Kankakee	16846	16597	625	*	
Monee	Sanger	16980	16646	786		
Morris	Morris Municipal	17004	16413	588		
New Lenox	New Lenox-Howell	17025	16571	745		
Paxton	Paxton	16578	16507	780		
Plainfield	Clow Intl.	17116	16502	670		
Romeoville	Lewis University	17081	16518	672		
Urbana	Frasca Field	16446	16488	735		

North and east coordinates align with orthogonal coordinate grid overlaid on Lambert conformal conic projection.

Seattle Area

						ILS
	City	Airport	North	East	Alt.	Fuel (Rwy/Freq.)
	Alderwood Manor	Martha Lake	21502	6670	500	
	Arlington	Arlington Municipal	21616	6737	137	
	Auburn	Auburn Municipal	21290	6586	57	
	Bremerton	Bremerton National	21407	6470	481	
	Everett	Snohomish Co.	21525	6665	603	* 16/109.3
	Issaquah	Issaquah	21362	6668	500	
	Monroe	Flying F. Ranch	21481	6738	50	
	Olympia	Olympia	21218	6343	206	*
	Puyallup	Pierce Co.-Thun Fld.	21206	6534	530	
	Port Angeles	William R. Fairchild Intl.	21740	6375	288	*
	Port Orchard	Port Orchard	21373	6483	370	
	Renton	Renton Municipal	21351	6612	29	
	Seattle	Boeing Fld./King Co. Intl.	21376	6596	17	*
	Seattle	Seattle-Tacoma Intl.	21343	6584	429	*
	Shelton	Sanderson Fld.	21353	6316	278	
	Snohomish Co. (Paine Field)	see Everett				
	Snohomish	Harvey Fld.	21505	6711	16	
	Spanaway	Shady Acres	21201	6501	425	
	Spanaway	Spanaway	21215	6491	385	
	Tacoma	Tacoma Narrows	21300	6480	292	

North and east coordinates are canted at -21° (counterclockwise) to compensate for orthogonal coordinate grid overlaid on Lambert conformal conic projection.

Los Angeles Area

City	Airport	North	East	Alt.	Fuel	ILS (Rwy/Freq.)
Avalon	Catalina (PVT)	15149	5744	1602	*	
Carlsbad	McClennan-Palomar	14931	6112	328		
Chino	Chino	15319	6079	650		
Compton	Compton	15334	5859	97		
Corona	Corona Municipal	15280	6083	533		
El Monte	El Monte	15397	5952	296		
Fallbrook	Fallbrook Community Airpark	15023	6144	708		
Hawthorne	Hawthorne Municipal	15358	5831	63		
Huntington Beach	Meadowlark	15244	5911	28		
LaVerne	Brackett Fld.	15378	6038	1011		
Los Angeles	Hughes (PVT)	15386	5808	22	*	
Los Angeles	Los Angeles Intl.	15374	5805	126	*	
Oceanside	Oceanside Municipal	14974	6095	28		
Ontario	Ontario Intl.	15347	6099	952		
Riverside	Riverside Municipal	15288	6141	816		
San Diego	San Diego Intl.- Lindbergh Fld.	14761	6102	15	*	
Santa Ana	John Wayne Airport/Orange Co.	15211	5961	54	*	
Santa Monica	Santa Monica Municipal	15402	5799	175	*	
Torrance	Torrance Municipal	15308	5815	101		
Van Nuys	Van Nuys	15498	5811	799	*	16R/111.3

North and east coordinates are canted at -19° (counterclockwise) to compensate for orthogonal coordinate grid overlaid on Lambert conformal conic projection.

San Francisco Area

City	Airport	North	East	Alt.	Fuel	ILS (Rwy/Freq.)
Antioch	Antioch	17406	5297	190		
Chico	Chico	18158	5567	239		
Columbia	Columbia	17269	5753	2116		
Concord	Buchanan	17452	5217	23		
Crows Landing	NALF Crows Landing	17256	5370	200	*	
Fremont	sky sailing	17224	5178	9		
Fresno	Chandler Downtown	16671	5752	279		
Fresno	Fresno Air Terminal	16679	5795	331		

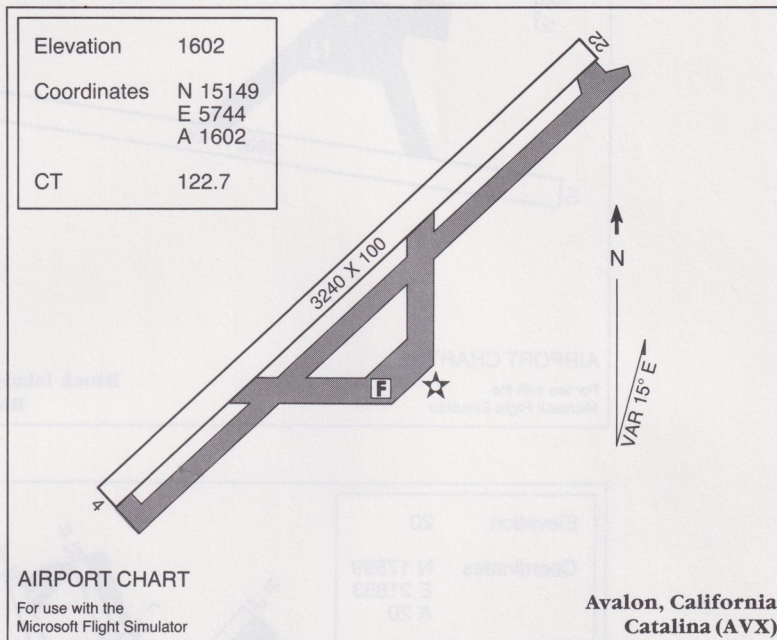
San Francisco Area (continued)

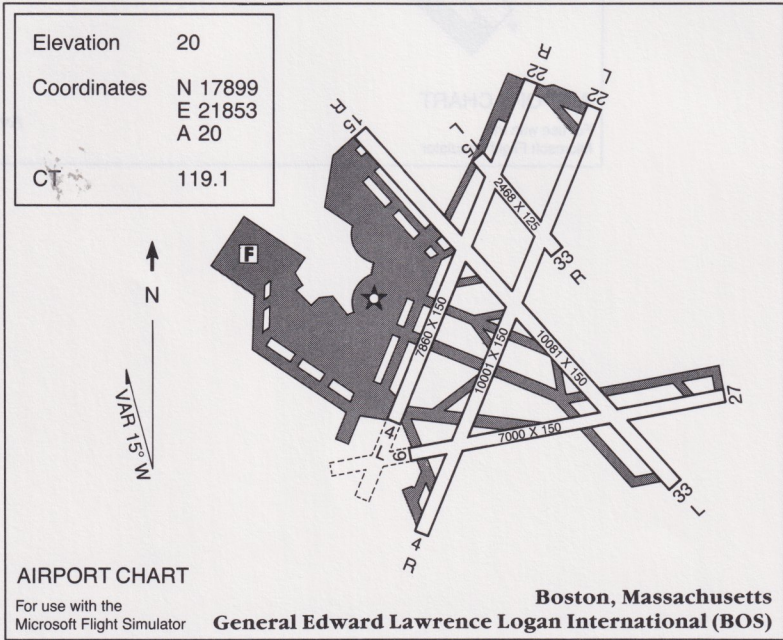
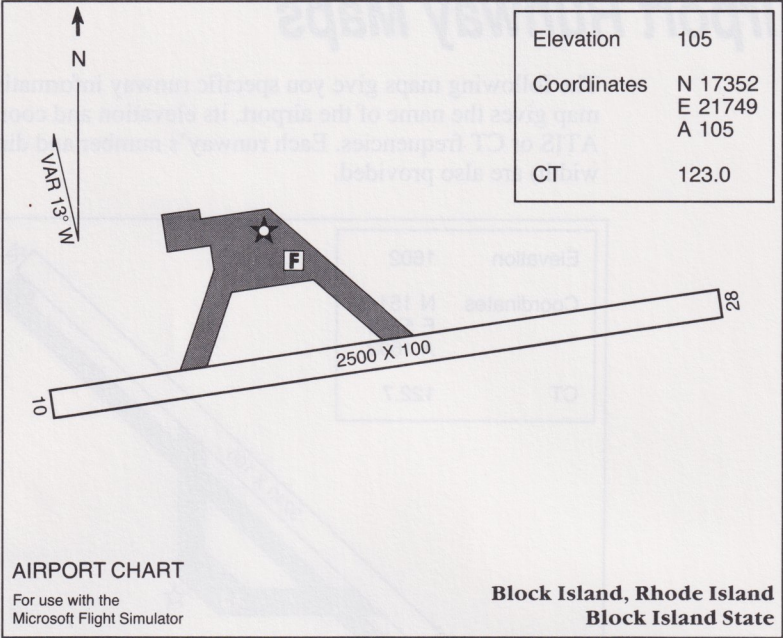
City	Airport	North	East	Alt.	Fuel	ILS
						(Rwy/Freq.)
Garberville	Garberville	18514	5010	544		
Hayward	Hayward	17328	5146	9		
Little River	Mendocino Co.	18174	4895	571		
Livermore	Livermore	17303	5251	397		
Lodi	Kingdon	17408	5460	16		
Lodi	Lodi	17447	5503	59		
Marysville	Yuba Co.	17840	5550	62		
Merced	Merced	16980	5608	154		
Minden	Douglas Co.	17584	6104	4717		
Modesto	Modesto City	17172	5518	98		
Monterey Peninsula	Monterey Peninsula	16862	5069	243		
Mountain View	NAS Moffett	17220	5133	9		
Novato	Hamilton	17532	5083	9		
Oakland	Metro Oakland Intl.	17363	5129	7	*	11/111.9 27R/109.9 29/108.7
Oakland	NAS Alameda	17404	5101	16		
Oroville	Oroville	18003	5592	200		
Palo Alto	Palo Alto	17243	5120	9		
Placerville	Placerville	17591	5748	2585		
Red Bluff	Red Bluff	18347	5500	348		
Reno	Cannon	17788	6176	4412		
Reno	Stead	17875	6169	5045		
Sacramento	Sacramento Metro	17681	5477	23		
Sacramento	Sacramento Exec.	17595	5482	23		
Salinas	Salinas	16856	5161	85		
San Carlos	San Carlos	17278	5085	9		
San Francisco	San Francisco Intl.	17340	5061	10	*	19L/108.9 28L/109.5 28R/111.7
San Jose	Reid-Hillview	17157	5195	134		
San Jose	San Jose	17184	5165	56	*	
Santa Rosa	Sonoma Co.	17756	5066	125		
Santa Rosa	Santa Rosa	17711	5066	98		
South Lake Tahoe	Lake Tahoe	17570	6016	6265		
Stockton	Stockton Metro	17312	5467	30		
Truckee-Tahoe	Truckee-Tahoe	17761	6031	5901		
Visalia	Visalia	16454	5831	292		
Watsonville	Watsonville	16995	5138	161		
Willows	Glenn Co.	18087	5409	138		

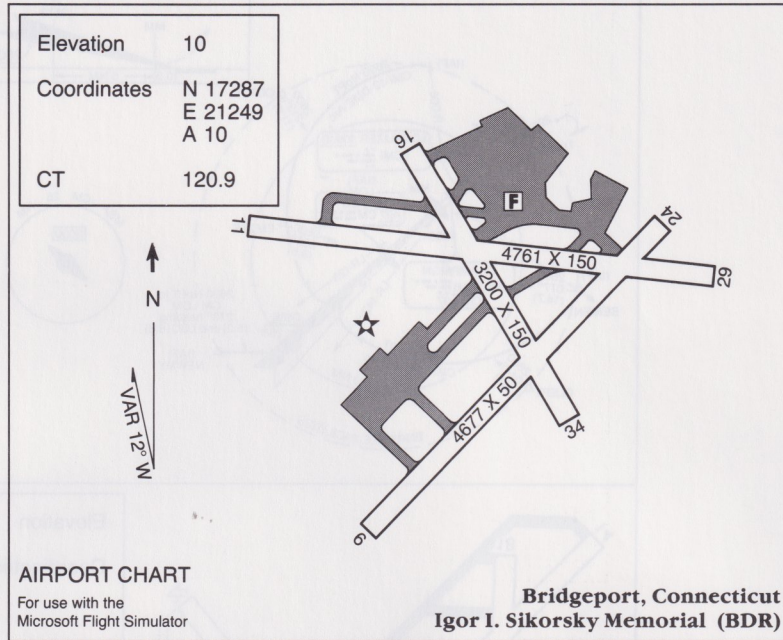
North and east coordinates are canted at -20° (counterclockwise) to compensate for orthogonal coordinate grid overlaid on Lambert conformal conic projection.

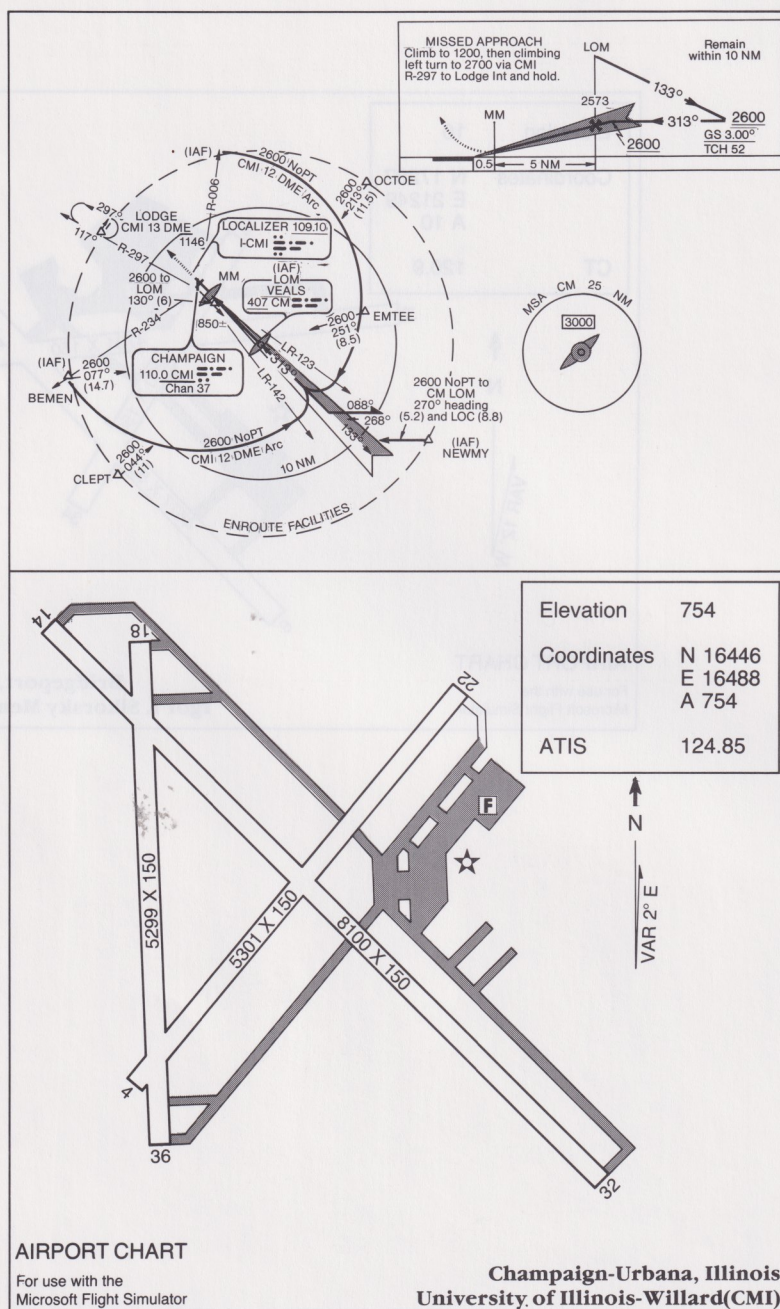
B: Airport Runway Maps

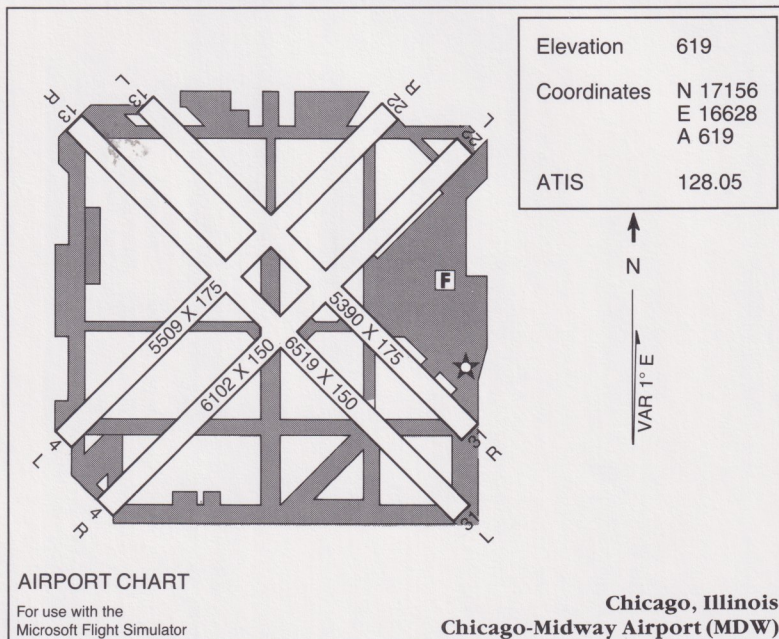
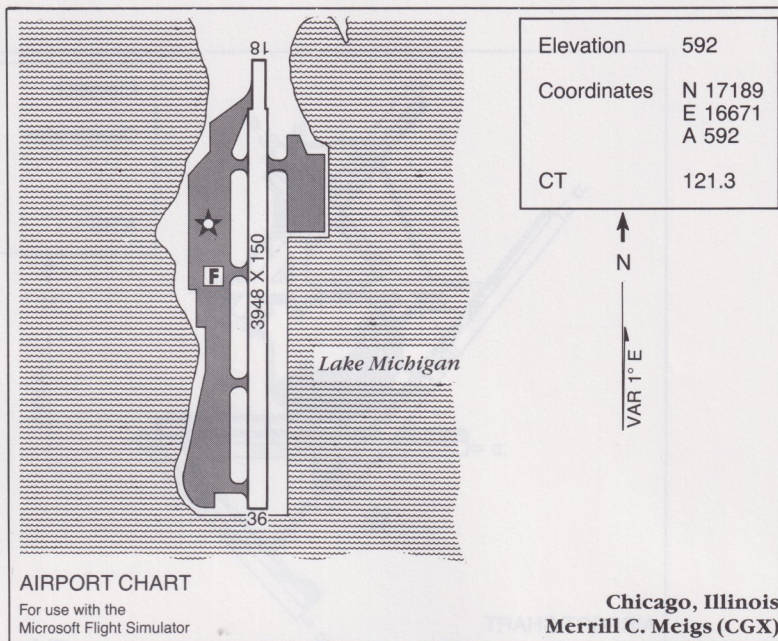
The following maps give you specific runway information for 23 airports. Each map gives the name of the airport, its elevation and coordinates, as well as its ATIS or CT frequencies. Each runway's number and dimensions (length by width) are also provided.

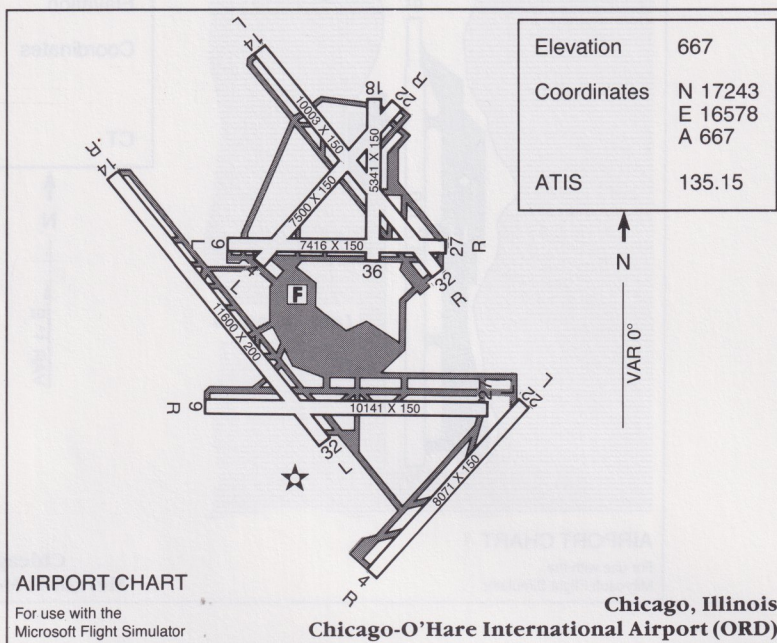


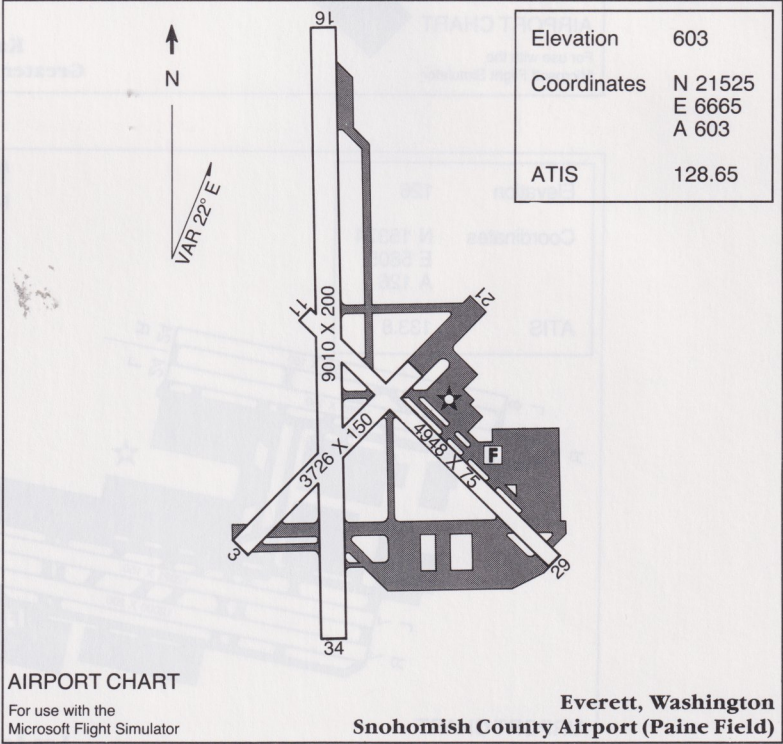
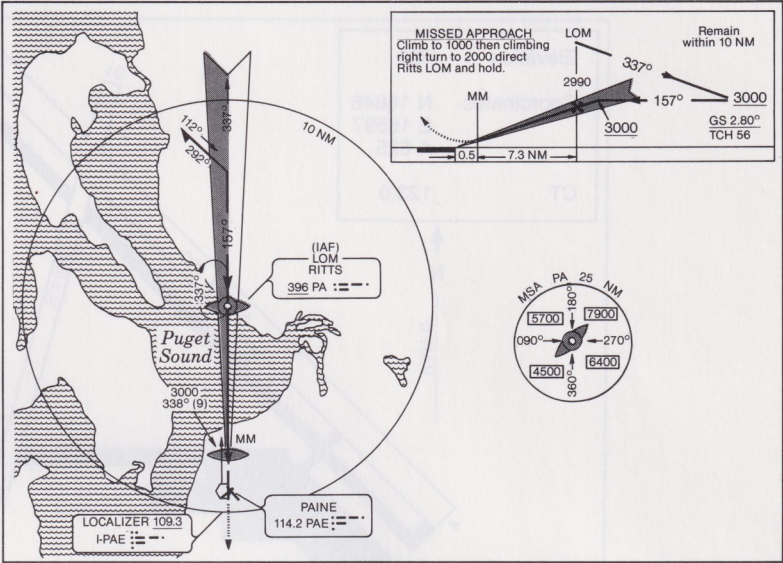


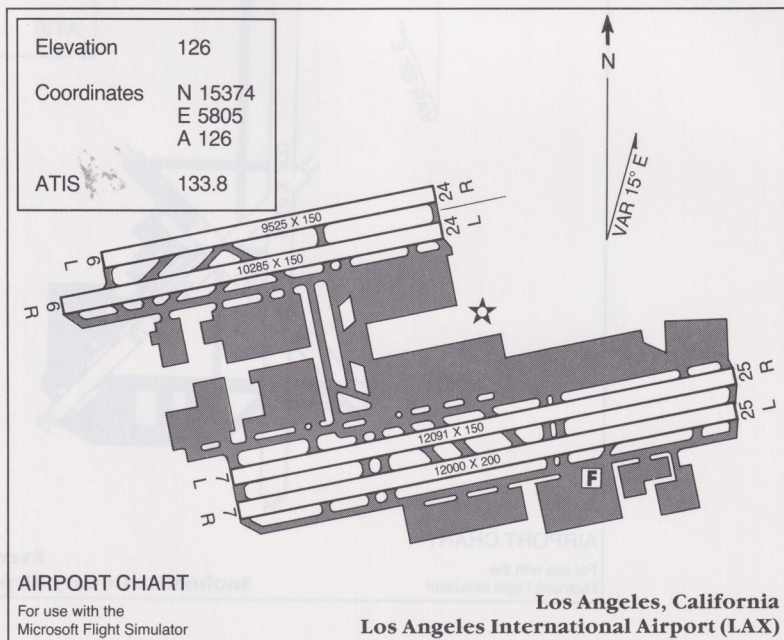
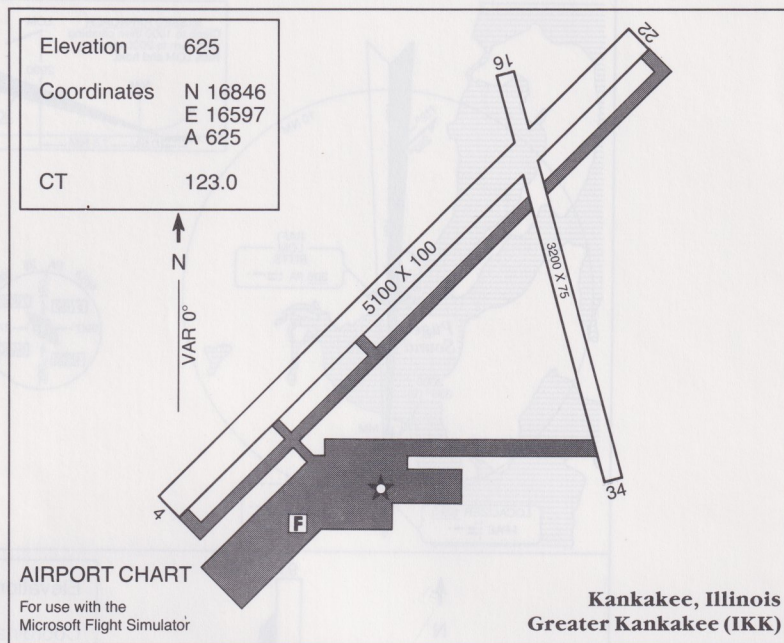






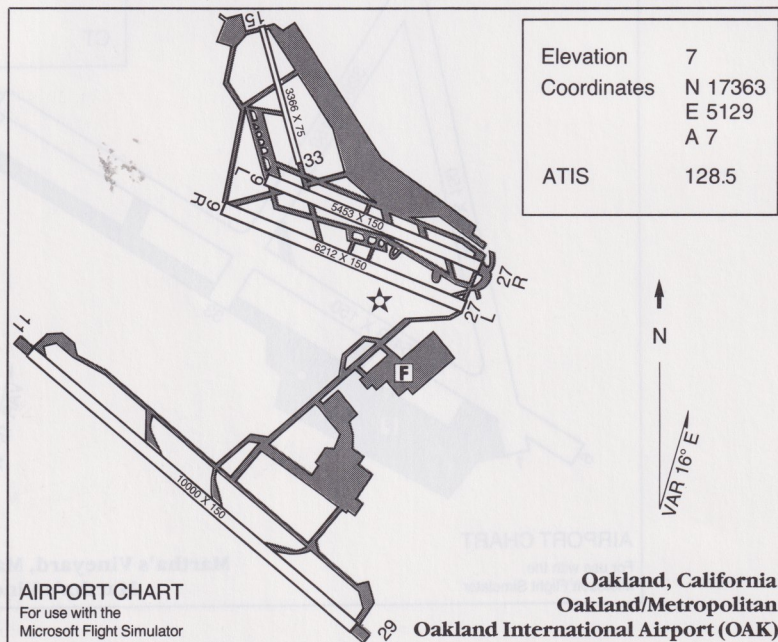
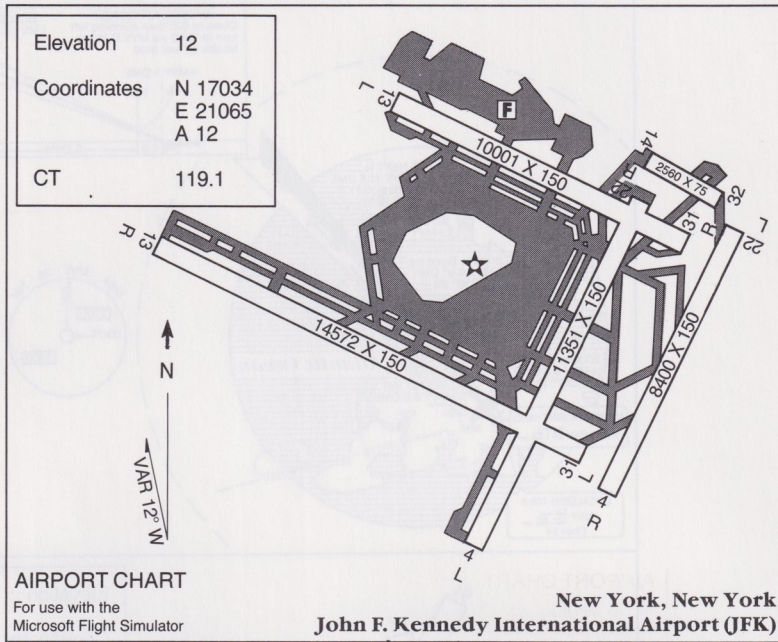


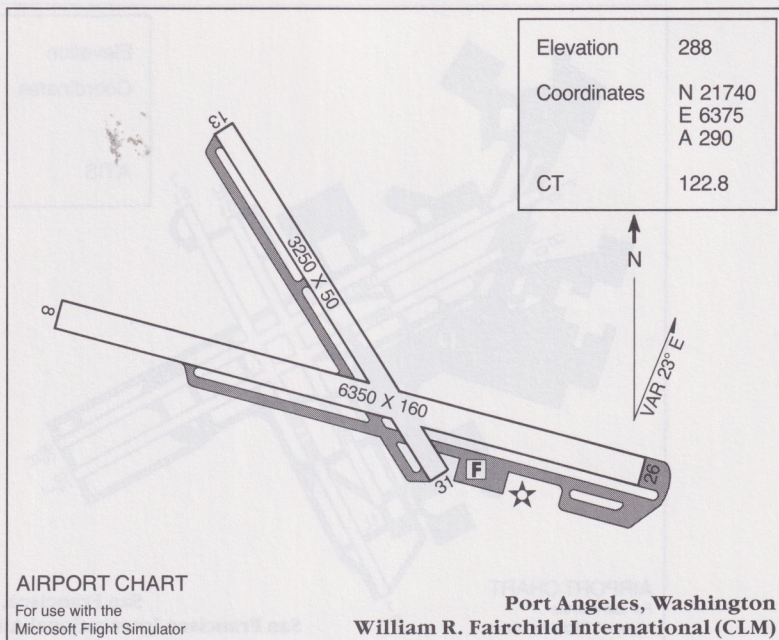
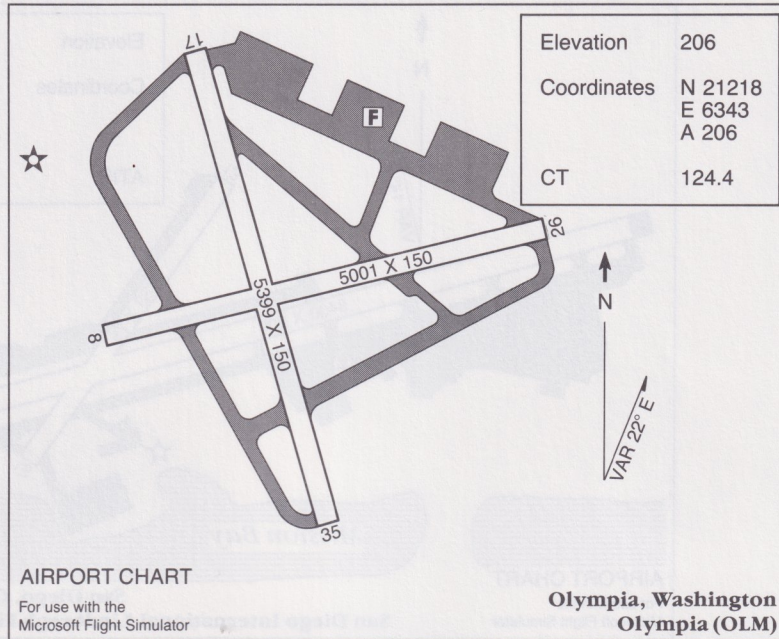


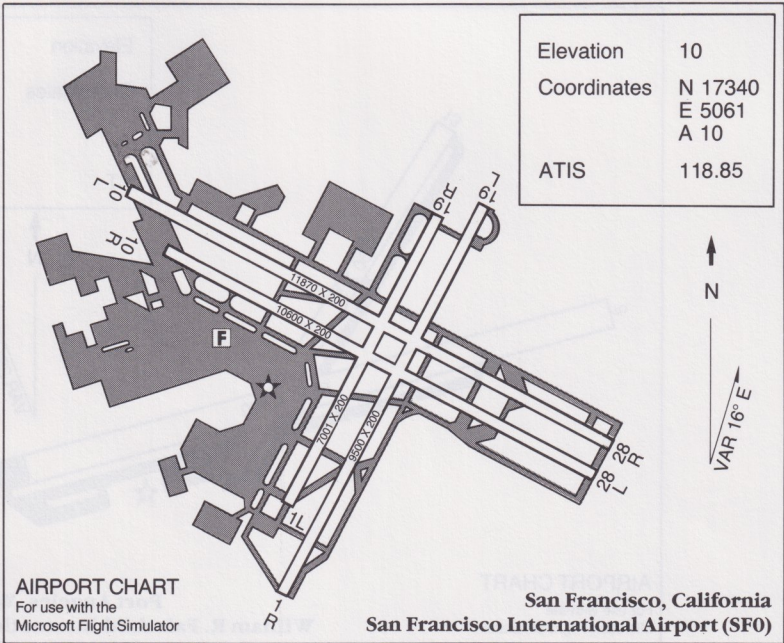
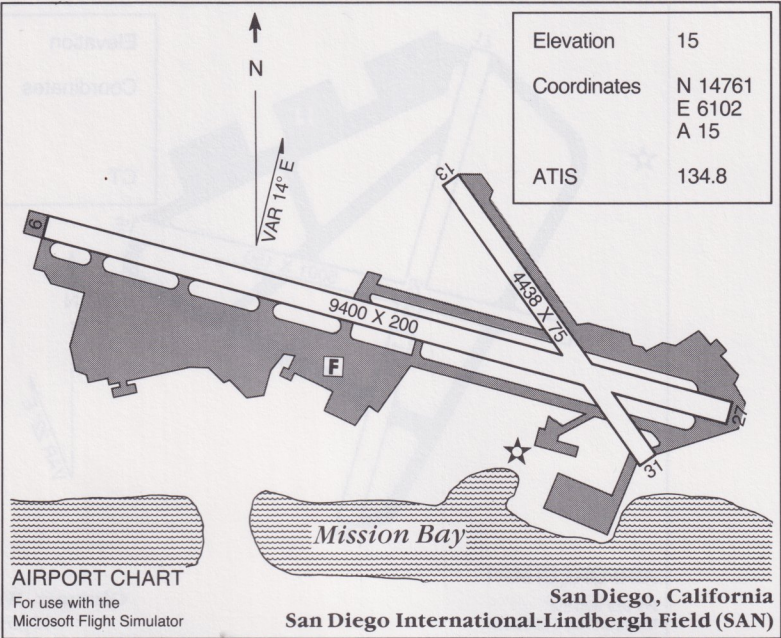


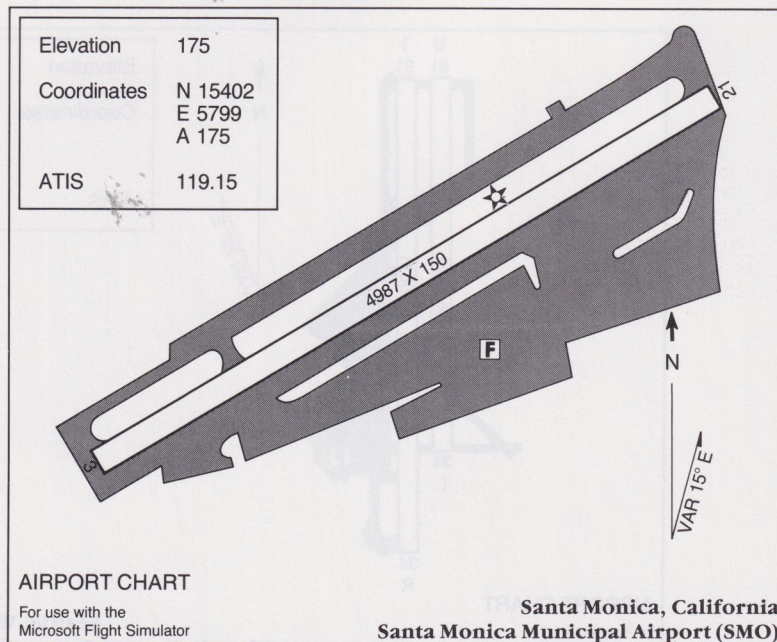
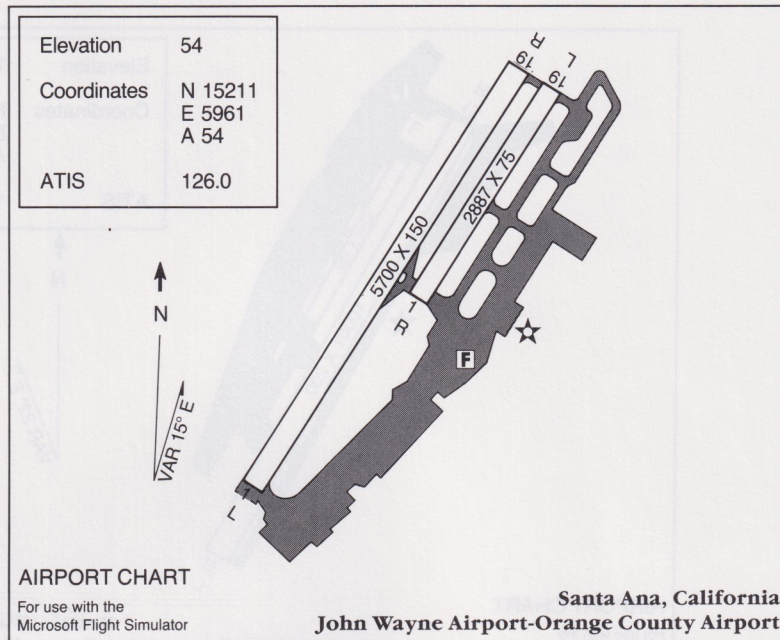
For use with the
Microsoft Flight Simulator

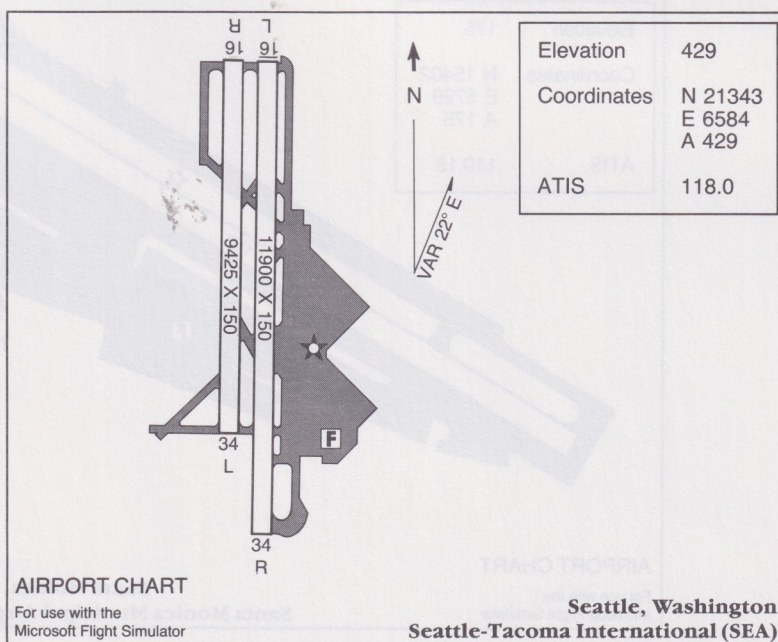
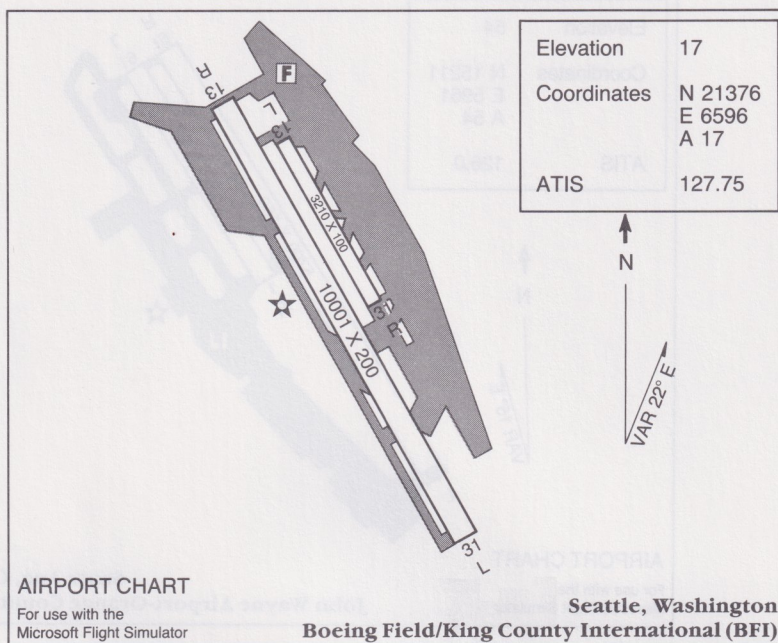
Martha's Vineyard, Massachusetts
Martha's Vineyard (MVY)

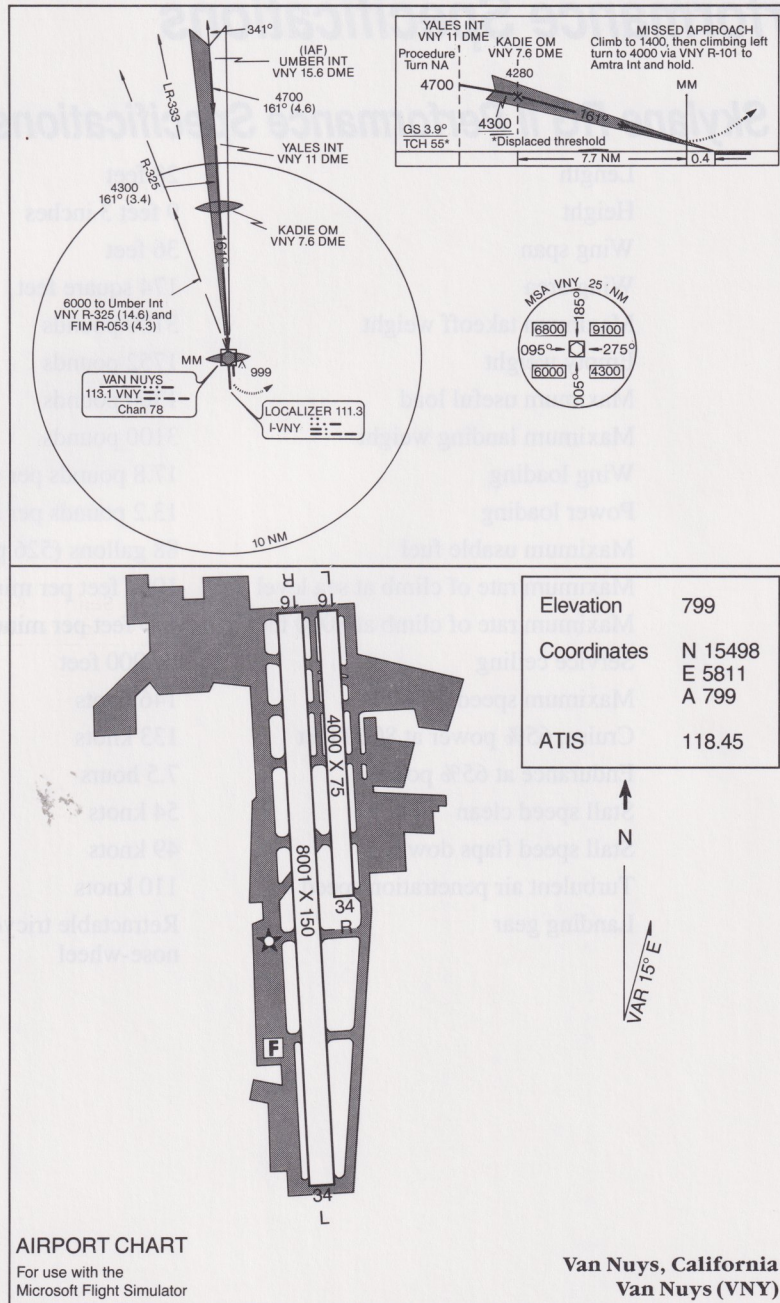












C: Performance Specifications

Cessna Skylane RG II Performance Specifications

Length	28 feet
Height	9 feet 3 inches
Wing span	36 feet
Wing area	174 square feet
Maximum takeoff weight	3100 pounds
Empty weight	1752 pounds
Maximum useful load	1360 pounds
Maximum landing weight	3100 pounds
Wing loading	17.8 pounds per square foot
Power loading	13.2 pounds per horsepower
Maximum usable fuel	88 gallons (526 pounds)
Maximum rate of climb at sea level	1050 feet per minute
Maximum rate of climb at 8000 feet	455 feet per minute
Service ceiling	14,900 feet
Maximum speed	146 knots
Cruise, 65% power at 8000 feet	133 knots
Endurance at 65% power	7.5 hours
Stall speed clean	54 knots
Stall speed flaps down	49 knots
Turbulent air penetration speed	110 knots
Landing gear	Retractable tricycle, steerable nose-wheel

Gates Learjet 25G Performance Specifications

Type designation	LR-25G
Engines	General Electric CJ610-8A, 2950 pounds each
Seats	10
Length	47 feet 7 inches
Height	12 feet 3 inches
Wing span	35 feet 7 inches
Wing area	247 square feet
Wing aspect ratio	5.5
Maximum ramp weight	16,200 pounds
Maximum takeoff weight	16,200 pounds
Standard empty weight	8250 pounds
Empty weight as tested	8616 pounds
Maximum useful load	8550 pounds
Zero-fuel weight	11,400 pounds
Maximum landing weight	13,700 pounds
Wing loading	66 pounds per square foot
Maximum altitude	51,000 feet
Power loading	12.8 pounds per pound
Maximum usable fuel	6638 pounds
Maximum pressurization differential	9.4 pounds per square inch
8000-foot cabin altitude at	51,000 feet
Normal cruise at 45,000 feet	445 knots
High speed cruise at 41,000 feet	464 knots
Fuel flow at normal cruise (as tested)	1370 pounds per hour
Stall speed clean	118 knots (14,500 pounds)
Stall speed full flaps	102 knots (14,500 pounds)
Stall speed flaps/gear down	99 knots

Schweizer 2-32 Sailplane Performance Specifications

Length	26.75 feet
Wing span	57 feet
Height	9 feet
Wing area	180 square feet
Aspect ratio	18.05
Gross weight	1340 pounds
Empty weight	831 pounds
Maximum L/D	34 at 45 knots
Minimum sink (solo)	2 feet per second at 40 knots

D: Using a Mouse and Joysticks

A mouse and one or two joysticks can be used for flight control functions.

This appendix includes instructions for setting up a mouse and joysticks, plus information about use, calibration, and sensitivity controls.

If Joystick A or B is active, it overrides the mouse yoke controls. Mouse pointer functions are still active when joysticks are used.

Using a Mouse

This section explains setting up a mouse, using a mouse in Pointer mode and Control Yoke mode, and adjusting mouse sensitivity.

Mouse Setup

To use the mouse, first install the mouse driver. The instructions that came with the Microsoft Mouse show how to install the mouse driver.

Note If you are using a Personal System/2 computer, be sure to plug the mouse into port 2.

Once the mouse driver is installed, start Flight Simulator by typing `fs`. Answer “Yes” to “Do you want to use the mouse?” If the mouse driver was not installed, you will get a message saying that no driver was found. You can continue without mouse control, or exit from the simulator, install the mouse driver, and restart the simulator.

When Flight Simulator starts running, a pointer will appear on the screen. Moving the mouse should move the pointer.

Pointer and Yoke Modes

In Flight Simulator, the mouse operates in two modes: Pointer mode and Control Yoke mode. Press the right mouse button to toggle between the two modes.

Pointer Mode

In Pointer mode, the mouse is used to select menu options. A pointer (arrow) moves around the screen when you move the mouse; you can select menus and options by clicking the left button. You can also adjust instruments on the instrument panel by pointing to an instrument and clicking the left mouse button. For example, you click the “A” on the altimeter knob to calibrate the altimeter, and click the Lights indicator to turn the lights on and off. On some instruments, such as the OBI, pointing to the left side of the digits and clicking the left button decreases the instrument setting, while pointing to the right side and clicking the left button increases it. These functions are described in chapter 2, “Aircraft Controls.”

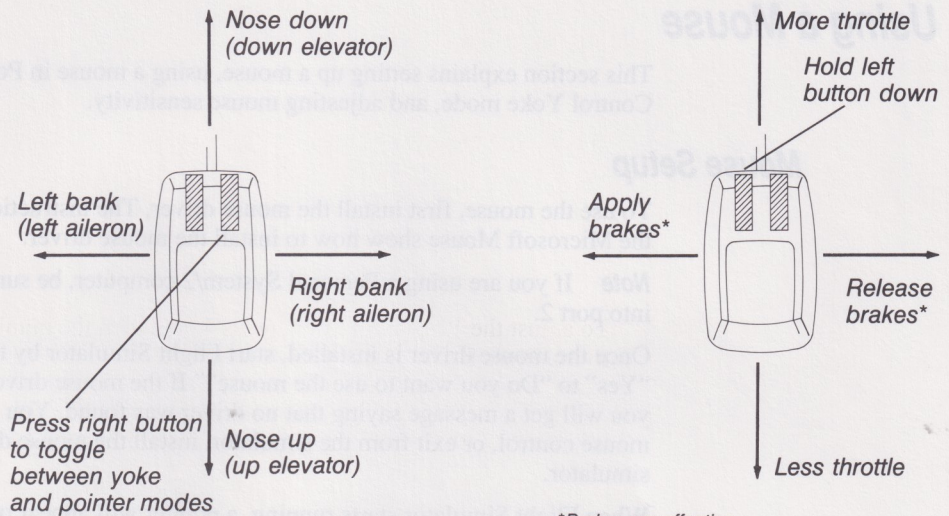
Control Yoke Mode

In Control Yoke mode, the mouse acts as the aircraft control yoke or stick. Figure D.1 shows mouse functions in yoke mode.

D.1 Mouse Functions in Control Yoke Mode

Move Mouse to Control
Elevators and Ailerons

Drag Mouse to Control
Brakes and Throttle



*Brakes are effective
only while on the ground.

Movements forward and backward control aircraft pitch (nose up and nose down); left and right movements control bank, which causes you to turn left or right. In Control Yoke mode, the mouse acts as if it were the tip of a large joystick. The elevator and rudder position indicators on the control panel move as the mouse is moved.

Throttle and brakes are also mouse-controlled in Control Yoke mode. Holding down the left button and dragging the mouse forward or backward increases or decreases throttle. Holding down the left button and dragging the mouse to the left applies brakes; dragging to the right releases them. The throttle indicator on the control panel shows throttle movement (engine RPM also changes as you move the throttle), and a brakes indicator near the bottom of the 3-D screen indicates that brakes are applied. Brakes are effective only on the ground and are automatically released when you are in the air so that you don't land with brakes on.

Toggling Between Pointer Mode and Control Yoke Mode

Press the right button on the mouse to toggle between Pointer mode and Control Yoke mode.

Mouse Sensitivity

Select option D, Mouse, on the Sim menu to adjust sensitivity for the mouse. To change a setting, select the option you want to adjust, and then press the number representing the sensitivity you want, where one is narrow (large mouse movement for slight yoke or pointer movement) and eight is wide. With the mouse, you can drag the pointer to the setting you want.

Adjusting Mouse Sensitivity

- 1 On the Sim menu, select option D, Mouse.
- 2 To adjust Yoke Sensitivity, press 1 for up-down adjustment or 2 for left-right adjustment, and then the number for the sensitivity. Press Esc.
- 3 To adjust Pointer Sensitivity, press 3, and then the number for the sensitivity. Press Esc.
- 4 To adjust the Yoke Null Zone, press 4, and then the number for the sensitivity. Press Esc.

The null zone is provided in the center of control movement to keep the plane from slowly drifting into a bank if the ailerons are positioned the slightest bit off-center. As long as the mouse is in this zone, the ailerons are centered. Too wide a null zone gives the ailerons a sloppy feel, while too small a zone makes it too easy to start banking unintentionally. Adjust to a balance between these two conditions.

Mouse sensitivities are saved as part of a flight mode. They can be loaded when a flight mode is loaded by selecting option A, Load Sensitivities From Mode File, on the Mouse Calibration menu.

Using Joysticks

To use joysticks, you need an IBM Game Control Adapter Card (or a compatible card) and one or two joysticks with buttons. The Game Control Adapter Card supports two joysticks, designated as Joystick A and Joystick B. With Flight Simulator, Joystick A is used to control ailerons and elevators, and Joystick B is used to control the throttle and brakes, or the throttle and rudder.

The IBM Game Control Adapter Card can handle two joysticks simultaneously. Since there is only one socket on the adapter, both joysticks must fit into a single connector. However, since joysticks are seldom sold in pairs, most use a connector designed for a single joystick.

The documentation supplied with your game adapter explains how to support two joysticks. You (or someone at your computer store) can build a Y-adapter. This splits the single connector into Joystick A and Joystick B sockets, allowing you to connect both joysticks simultaneously.

Check with your dealer or the manufacturer of your joystick to see if an adapter has already been made for this purpose.

Some game cards have external switches for fine tuning. If you have such a card and the wrong switch setting is used, sound quality can suffer and become erratic. Experiment with the switch settings until the best sound quality is found.

Joystick Setup

Joysticks are either self-centering, which means that the stick returns to the center position when released, or noncentering. Ailerons and rudder can be controlled with either a noncentering or self-centering joystick. Only a noncentering joystick can be used to control the elevators and the throttle.

Many joysticks have mechanical switching levers to enable or disable the self-centering springs. These switches are usually on the underside of the joystick case.

The ideal setup for Flight Simulator joysticks is:

- Ailerons (Joystick A, X-movement), self-centering
- Elevators (Joystick A, Y-movement), noncentering
- Throttle (Joystick B, Y-movement), noncentering
- Brakes (Joystick B, X-movement), self-centering
- Rudder (alternate Joystick B, X-movement), self-centering

You may be able to disable the self-centering mechanism on joysticks that do not have switching levers. However, check with your joystick manufacturer before attempting any alteration.

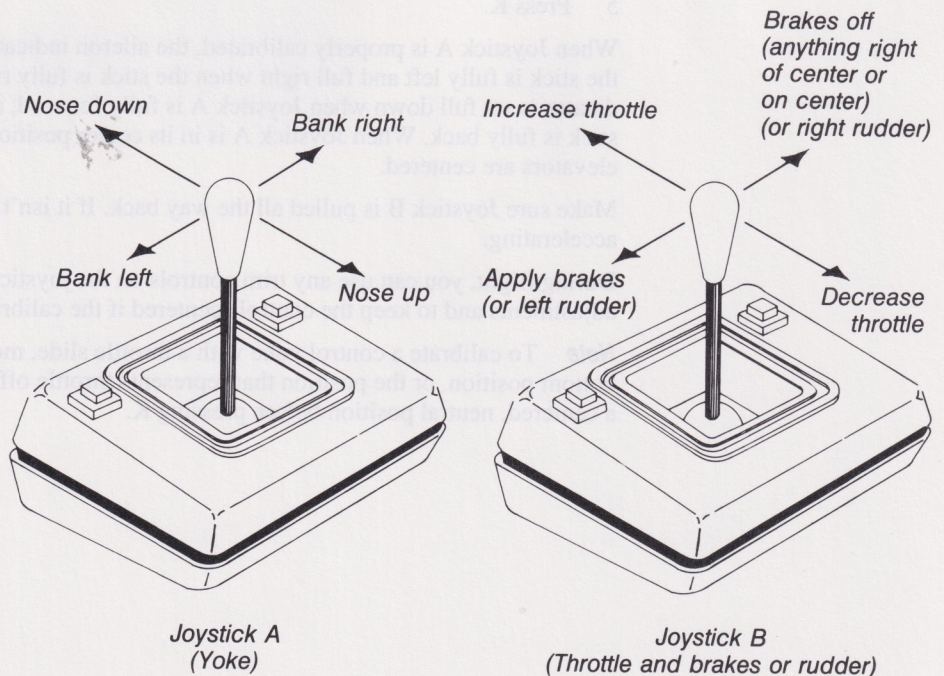
Installing Joysticks

- 1 Turn the computer off and install the Game Control Adapter Card and joystick(s) according to the instructions that accompanied these products.
- 2 Turn on the computer and start Flight Simulator.
- 3 Press 1 to go through the startup menus.
- 4 On the Joystick Selection Option menu, press Y to use joysticks.
- 5 Select the option that represents the joystick arrangement you want.
- 6 Follow the instructions on the screen to calibrate the joysticks. For more information, see "Joystick Calibration" next in this appendix.

Joystick A controls the ailerons and the elevators (and the rudder in auto-coordinated mode). Sideways movement (on the X-axis) controls ailerons and roll, and forward and backward movement (on the Y-axis) controls elevators and nose up and down (see figure D.2). Slowly move the stick through its complete X and Y range, watching the elevator and aileron (and auto-coordinated rudder) indicators move. The movement may be jumpy, and pushing the stick in a specific direction may not move the ailerons or elevators in that direction. Calibration will solve these problems.

Joystick B controls the throttle and brakes or rudder. Full forward provides full throttle, and full back reduces engine speed to an idle (see figure D.2). Left motion applies brakes; centered and right are brakes off.

D.2 Joystick Functions



Joystick Calibration

After turning on the joysticks, you must calibrate them. Joysticks vary greatly from one manufacturer to another. The range of numerical values generated also varies widely. The IBM Game Control Adapter Card specification calls for joysticks with 0–100K-ohm resistance and linear response. Joysticks with these characteristics work best with Flight Simulator.

The following calibration procedures compensate for joystick tolerance and for joysticks that deviate from IBM specification.

Calibrating Joystick A

- 1 Move the yoke joystick (joystick A) to its aileron and elevator center positions.
- 2 Center its trim controls, if any.
- 3 Press K.

Calibrating Joysticks A and B

- 1 Move the yoke joystick (joystick A) to its aileron and elevator center positions.
- 2 Center its trim controls, if any.
- 3 On the throttle joystick (joystick B), center the trim controls, if any.
- 4 Pull the throttle joystick all the way back, and center it in the X-direction.
- 5 Press K.

When Joystick A is properly calibrated, the aileron indicator is set full left when the stick is fully left and full right when the stick is fully right. The elevator indicator is set full down when Joystick A is fully forward, and full up when the stick is fully back. When Joystick A is in its center position, the ailerons and elevators are centered.

Make sure Joystick B is pulled all the way back. If it isn't, the plane will start accelerating.

During flight, you can use any trim controls on the joysticks to make minor adjustments and to keep the controls centered if the calibration drifts.

Note To calibrate a control yoke with a throttle slide, move the slide to the bottom position, or the position that represents throttle off, and place the yoke in a centered, neutral position before pressing K.

Adjusting Joystick Sensitivity

To adjust joystick sensitivity, select option E, Joystick, on the Sim menu. You can also use the Joystick menu to turn joysticks on and off and to calibrate them. To change a setting, select the option you want to adjust, and then press the number representing the sensitivity you want, where one is not very sensitive and eight is very sensitive. With the mouse, you can drag the pointer to the setting you want.

Adjusting Joystick Sensitivity

- 1 On the Sim menu, select option E, Joystick.
- 2 To adjust stick A sensitivity, press A for left-right adjustment or B for up-down adjustment, and then the number for the sensitivity. Press Esc.
- 3 To adjust stick B sensitivity, press C for up-down adjustment or D for left-right adjustment, and then the number for the sensitivity. Press Esc.
- 4 To adjust the null zone width, press E to adjust stick A or F to adjust stick B, and then the number for the sensitivity. Press Esc.

The null zone is provided in the center of control movement to keep the plane from slowly drifting into a bank if the ailerons are positioned the slightest bit off-center. As long as the joystick is in this zone, the ailerons are centered. Too wide a null zone gives the ailerons a sloppy feel, while too small a zone makes it too easy to start banking unintentionally. Adjust to a balance between these two conditions.

Joystick sensitivities and joystick action selections are saved as a part of a flight mode. They can be loaded when a flight mode is loaded by selecting option 5, Load Sensitivities From Mode File, on the Joystick Calibration menu.

E: Keyboard Summary

This appendix summarizes all the keyboard functions used to control the airplane.

Controlling Windows and Views

To select	Press
3-D window 1	[
3-D window 2]
Map window	NumLock

To turn off a window, press the window's select key twice.

To zoom a window, press the window's select key and the plus key (in), the minus key (out), or Backspace (1X). For fine zoom adjustments, press Shift+plus key or Shift+minus key.

To change the overlapping window, press the select key for the window you want on top, and then press the apostrophe (') key.

To change view direction, press Scroll Lock, and then the view direction key (1–9 on the numeric keypad).

To select window mode, press S to cycle through Cockpit, Tower, Track, and Spot.

To pan up or pan down in Cockpit mode, press Shift+Backspace or Shift+Enter.

Airplane Controls

Control	Key
Lights on/off	L
Carb heat on/off	H
Landing gear up/down	G
Autopilot on/off	Z
Magneto	M, followed by 1 (off), 2 (left), 3 (right), 4 (both), 5 (start), or 0 (lean-cutoff)
Brakes	. (period)
Pause/restart simulation	P
Strobes on/off	O
Sound on/off	Q
Smoke/spray on/off	I

Flight Controls

All keys refer to the numeric keypad.

Control		Keys	
Ailerons	Left	4	
	Center	5	
	Right	6	
Elevator	Nose up	2	
	Nose down	8	
Elevator trim	Nose up trim	1	
	Nose down trim	7	
Rudder	Left yaw	0	
	Center rudder	5	
	Right yaw	bottom-right key*	
Flaps	Up	F5 (top)	F1 (left)
	1 notch	F6	F3
	2 notches		F5
	3 notches	F7	F7
	Down	F8	F9
Throttle	Decrease	3	
	Increase	9	
	Cut	F1 (top)	F10 (left)
	Decrease/less	F2	F8
	Increase slow		F6
	Increase fast/more	F3	F4
	Full	F4	F2

*On some keypads, the bottom-right key is plus; on others, it is Enter. Ignore the keycap legend and use the bottom-right key.

Menu System

To	Press
Turn on/turn off the menu bar	Esc
Remove a menu or back up through menus	Esc
Remove all menus and return to simulator	Spacebar

Calibration

Instrument	Key
Altimeter	A
Directional Gyro	D

Setting Radios

Radio	Keys
ADF	N2 followed by plus key or minus key; NN, NNN followed by plus key or minus key for fractional frequency
COM	C followed by plus key or minus key; CC followed by plus key or minus key for fractional frequency
NAV	N1 or N2 followed by plus key or minus key; NN followed by plus key or minus key for fractional frequency
Transponder	T (first digit), TT (second), TTT (third), or TTTT (fourth), followed by plus key or minus key
VOR OBI	V1 or V2 followed by plus key or minus key
DME	B for alternate source NAV 1/NAV 2 F for readout of speed toward station

WWI Ace

To	Press
Declare war	W
Display war report	R
Drop bomb	X
Fire machine guns	Spacebar

Slewing

Function	Key	
Altitude up	Q	
Altitude down	A	
Nose up	9 (main keyboard)	
Nose down	0 (main keyboard)	
Pitch slew	Nose up quick	F5 (top) F9 (left)
	Nose up slow	F7
	Freeze	F6, F7 F5
	Nose down slow	F3
	Nose down quick	F8 F1
Altitude slew	Down quick	F1 (top) F10 (left)
	Down slow	F8
	Freeze	F2, F3 F6
	Up slow	F4
	Up quick	F4 F2
Bank slew left	7 (keypad)	
Bank slew right	9 (keypad)	
Heading slew left	1 (keypad)	
Heading slew right	3 (keypad)	
Slew forward	8 (keypad)	
Slew backward	2 (keypad)	
Slew right	6 (keypad)	
Slew left	4 (keypad)	
Freeze	5 (keypad)	
Turn digits on/off	Z	
Set observation angle to straight ahead pitch, north heading, 0-degree bank	Alt	

Glossary

Terms printed in *italic* in the Glossary are defined elsewhere in the Glossary.

A

Accelerated maneuver stalls Stalls hastened by excessive maneuvering loads, imposed by turns, pullups, or other abrupt flight path changes.

Active runway Most large airports have more than one runway. The runway being used is called the “active runway.” It is usually impractical to have takeoffs and landings from more than one runway at a time because they usually cross each other so that the airport can handle takeoffs and landings under varying wind conditions. If the airport has only one runway, the “active runway” tells you in which direction traffic is taking off and landing.

Ailerons The surfaces on the outside trailing edges of the wings that control *roll*.

Airfoil A general term describing a surface or body, such as a wing or propeller blade, designed to obtain a reaction, such as lift or thrust, from the air through which it moves. Engineers use the term to describe the special shape that produces lift.

Airspace Roughly, the air around a given area. For example, the air around the United States is called the “United States’ airspace.”

Airspeed indicator The indicator that provides the aircraft’s present indicated airspeed. See also *ground speed* and *true airspeed*.

Altimeter The indicator that gives information on the aircraft’s present altitude. It is usually calibrated to give mean sea level (MSL) altitude. Most altimeters are called pressure altimeters because they measure the decrease in pressure as the aircraft climbs. Because of this, the altimeter must be calibrated to the local *atmospheric pressure* to compensate for local variations in the pressure that would make the readings inaccurate.

Angle of attack The angle between the wing’s *chord* line and the relative wind.

Artificial horizon The indicator that provides an in-the-cockpit reference for the attitude of the aircraft with respect to the ground. It is used to provide attitude references when the true horizon cannot be seen, such as when flying into a cloud.

Aspect ratio Ratio between the wing span and the mean *chord* of the wings.

ATC Air Traffic Control. The ground-based radio network consisting of Ground Control (controls taxiing to and from the *active runway*), Tower (controls the runway itself, giving permission to land and take off), Departure (controls aircraft departing from a specific airfield), Center (controls the airspace at higher altitudes), and Approach (controls those aircraft arriving into the airspace immediately surrounding the airfield).

ATIS Automatic Terminal Information Service. A continuous-loop recording, usually updated once an hour, played over a specified frequency giving weather and other important information for an airfield. Air traffic controllers use the *phonetic alphabet* to relay frequencies over the air.

Atmospheric pressure The pressure exerted by the air on the earth and everything on it. This is measured in inches (or millibars) of mercury on an instrument called a barometer. Thus, the term *barometric pressure* is frequently interchanged with atmospheric pressure. Typically, the pressure is between 28 and 32 inches of mercury at sea level.

Attitude flying Flying based on the attitude, or aircraft's orientation (notably *pitch* and *bank*), to the world around it.

Auto-coordinated The term that describes the connection between the *rudder* and *ailerons* that automatically moves one as the pilot moves the other, resulting in properly coordinated turns (no *slips* or *skids*).

B

Bank See *roll*.

Barometric pressure See *atmospheric pressure*.

Bleed off The process in which a given parameter, such as airspeed or altitude, is slowly decreased in a carefully controlled manner.

C

Canted gyroscope A gyroscope within a flight instrument, usually the turn coordinator, with a rotational axis that is tilted or canted with the aircraft's *longitudinal axis*. The tilted axis causes the gyro to respond to *rolling* or *yawing* motion.

Ceiling The altitude of the lowest broken or overcast cloud layer.

Chord The measurement of the wing taken from the leading edge to the trailing edge.

COM Short for communication. Usually taken to mean the communication radio.

Control yoke The control wheel and connections that control the *ailerons* and *elevators*. The ailerons are controlled by turning a "steering wheel," and the elevators are controlled by moving the wheel toward or away from you. Some airplanes have a "stick" in place of a control yoke.

Coordinated flight See *auto-coordinated*.

D

Dead reckoning The navigation of an airplane solely by computations based on airspeed, course, heading, wind direction and speed, ground speed, and elapsed time.

Density altitude The altitude in the standard atmosphere (surface temperature 59°F and pressure 29.92 inches at sea level) where air has the same density as the air at the altitude being considered.

Dihedral The angle (if any) at which the wings are tilted upward. Upward dihedral, which forms a slight “V” shape as you look at an aircraft’s front view, increases stability and tends to level a plane automatically after a turn.

Directional gyro See *heading indicator*.

Distance Measuring Equipment (DME) A radio that determines and displays distance from a *VOR* in nautical miles.

Drag Those forces that oppose the movement of an aircraft through the air.

E

Elevators The control surfaces on the trailing edge of the *horizontal stabilizer* that control the aircraft’s *pitch*. When the elevators are down (the yoke is pushed forward), the stabilizer is pushed up by the air. This forces the nose down and causes the aircraft to dive. The opposite is true for climbs.

Empennage Tail of an airplane.

F

FAA Federal Aviation Administration. This agency, under the direction of the Department of Transportation, is responsible for maintaining safe and efficient use of the nation’s *airspace* by military and civil aviators, for fostering civil aeronautics and air commerce in the U.S. and abroad, and for supporting the requirements of national defense.

Fixed Base Operators A person or organization at an airport that sells fuel, sells or rents aircraft, and possibly gives flight instruction.

Flaps Movable *airfoil* sections, located on the trailing edge of the wings, that are lowered on takeoff and landing to increase the wings’ *lift* and *drag*.

Flare Leveling off a foot or two above the runway prior to landing by raising the nose of the aircraft just prior to touchdown. This is the last segment of a landing approach.

G

Glideslope A navigation aid used on *ILS* approaches in the terminal-area electronic navigation system that provides vertical guidance to aircraft as they approach the runway for landing.

Ground speed The aircraft's actual speed relative to the ground. For example, if an aircraft is flying level at 120 knots *true airspeed* and has a 15-knot headwind, its ground speed is 105 knots.

H

Heading The direction in which the aircraft is pointed. This is not necessarily the direction the plane is traveling. It is usually referred to as a magnetic heading, but "degrees" typically is omitted by experienced pilots ("My heading is 324").

Heading indicator (directional gyro) A gyroscopically controlled compass that is designed to give *heading* information based on the forces acting on a gyroscope, rather than an actual magnetic reading. It is used to provide a more accurate readout of *heading* without having to deal with magnetic compass lag and "settling time" after a turn, descent, acceleration, or deceleration climb.

Horizontal stabilizer The surface that is used to provide stabilization along the aircraft's lateral axis (helps to control *pitch*). Usually thought of as part of the airplane's "tail" or *empennage*.

I

Initial climb Your climb away from the runway, after *liftoff*.

Instrument Flight Rules (IFR) The "rules of the road" that cover flight in *Instrument Meteorological Conditions (IMC)* and high altitudes.

Instrument Landing System (ILS) A system of radio transmitters and receivers and special flight rules that provide a three-dimensional in-the-cockpit reference for landing. The radio signals consist of a localizer, which is similar to a *VOR* except that it transmits a single, very directional signal that leads you to a specific runway at an airport on the correct *heading*; the *glideslope*, which does much the same, except that it does so in the vertical, assuring that touchdown will be on the runway, and not before or after; outer, middle, and inner marker beacons that indicate distance from the runway; and approach lights. The instruments used are the glideslope needle and the localizer needle. These instruments are part of the *Omni-Bearing Indicator*.

Instrument Meteorological Conditions (IMC) Weather conditions that force flight under *Instrument Flight Rules (IFR)*.

Isogonic lines Lines of equal *magnetic variation* of true north from magnetic north due to the different locations of the true and magnetic poles of the earth.

K

Knots Nautical miles per hour. A “nautical mile” is defined as 1 minute of longitude at the equator, or 1.15 statute miles. To convert from knots to statute miles per hour, multiply knots by 1.1507; to convert the other way, multiply statute miles per hour by .869.

L

Landing gear The wheels, struts, and other equipment that the aircraft uses to land and maneuver on the ground. Landing gear typically come in one of two variations: “tail dragger,” in which the aircraft seems to sit on its tail; and “tricycle,” in which the plane sits level with the ground with one nose-wheel and two wheels farther back on the plane. The main landing gear are those nearest the aircraft’s center of gravity, and almost always come in pairs (left and right main gear). They are designed to take more landing shock than the more fragile nose-wheel or tail-wheel.

Lateral axis Imaginary axis running from side to side through the wings.

Lift Upward force on the aircraft.

Liftoff Movement by which the aircraft leaves the ground on takeoff.

Longitudinal axis Imaginary axis running from front to rear through an aircraft’s center of gravity and approximately parallel to the thrust line (the propeller’s axis).

M

Magnetic variation The variation angle between “true north” and “magnetic north.” This varies from location to location and must be considered when navigating long range.

Magneto A device that combines the functions of an automobile engine’s coil and distributor. It takes energy from the aircraft engine in the form of rotational energy and, by use of magnetics and induced electricity, creates the high voltages required for the spark plugs to fire.

Maneuvering speed The speed above which full control surface deflection could create excessive G forces that could damage the aircraft’s structure.

Manually coordinated (uncoordinated) flight See *uncoordinated flight*.

N

NAV Short for Navigational. Usually means the navigational radio.

NAV-COM A radio that combines the functions of a communication radio with those of a navigational radio.

Nose over To pitch forward, often resulting from the plane's lift being behind the center of gravity.

O

Omni-Bearing Indicator (OBI) The indicator that provides information about the aircraft position relative to the tuned *VOR* station. Usually provides the ability to "dial in" or select a given course or radial, and includes a TO-FROM indicator and a Course Deviation Indicator (CDI). On aircraft with *ILS* capabilities, a Glideslope Deviation Indicator (GDI) is also incorporated in this instrument. There is no official name for this instrument. It is sometimes referred to as the Omni-Bearing Selector (OBS) or VOR receiver and indicator.

P

Phonetic alphabet A special way of saying letters and numbers that makes them less likely to be misunderstood over a radio.

A ALPHA	N NOVEMBER	1 WUN
B BRAVO	O OSCAR	2 TOO
C CHARLEY	P PAPA	3 TREE
D DELTA	Q QUEBEC	4 FOWER
E ECHO	R ROMEO	5 FIVE
F FOXTROT	S SIERRA	6 SIX
G GOLF	T TANGO	7 SEVEN
H HOTEL	U UNIFORM	8 AIGHT
I INDIA	V VICTOR	9 NINER
J JULIET	W WHISKEY	0 ZEEROH
K KILO	X XRAY	
L LIMA	Y YANKEE	
M MIKE	Z ZULU	

In addition, numbers are usually spoken as individual digits. For example, 123 would be read as "wun too tree."

Pilotage Flying cross-country, from one visible landmark to another, using only a flight chart.

Pitch The movement of the aircraft about its lateral axis (nose up or nose down). If the nose is pointed down, it is "pitched forward"; when it is pointed up, it is "pitched backward."

Power glide A long, shallow approach in which engine power is used to maintain the glide. Power glides should be avoided when they are not required to maintain IFR approach angles, because an engine failure can cause you to land short of the runway.

R

Radials Directional beams that radiate from a VOR station.

Radio stack The area where the *COM*, *NAV*, and *transponder radios* are installed in the instrument panel. They are usually installed “on top of one another” as though they were stacked.

Rate of climb The rate (measured in feet per minute) at which an aircraft is climbing. The term is also loosely stretched to include the rate of descent. The rate of climb is read on the *rate of climb indicator*. If an aircraft is at 1000 feet and is climbing at 500 feet per minute, then it will be at 1500 feet in one minute.

Rate of climb indicator The indicator that gives information on the rate of increase and decrease of an aircraft’s altitude. Also known as a Vertical Speed Indicator (VSI) or Vertical Velocity Indicator (VVI).

Rate of sink See *sink rate*.

Roll Those actions taking place about the aircraft’s *longitudinal* (or roll) *axis*.

Rotation Pulling back the control yoke and raising the nose off the ground.

Rotation speed The speed at which the pilot should pull back on the control yoke to begin rotation during takeoff.

Roundout See *flare*.

Rudder The control surface, mounted on the trailing edge of the *vertical stabilizer* (the tail), that controls *yaw*.

Running lights The anti-collision light system required by the *FAA* on all aircraft in flight. The system includes flashing or rotating beacon position lights (a red light on the left wingtip, green on the right, and white on the tail). These tell another aircraft which direction an aircraft is flying when only the lights can be seen.

S

Sink rate Negative vertical velocity expressed in feet per second.

Skid An aircraft’s sideways sliding away from the center of the curve while in a turn.

Slip An aircraft’s sideways motion while turning.

Standard pressure 29.92 inches of mercury, or 1013 millibars. The pressure to which you calibrate when flying at an altitude above 17,999 feet.

T

Standardized instrument cluster An industry-accepted de facto standard for the placement of the six most commonly used flight instruments. The top row includes (from left to right) the *airspeed indicator*, attitude indicator, and *altimeter*. The bottom row includes (from left to right) the turn coordinator (or needle/ball), *heading indicator*, and *rate of climb indicator*.

Tachometer The instrument that shows the speed of rotation of the engine. It is marked in revolutions per minute (RPM).

Takeoff roll You apply full power and the plane accelerates until it gets to flying speed.

Taxi To move the aircraft on the ground.

Throttle The control that determines the speed of the engine.

Thrust Forward force generated by the propeller or jet engine.

Transponder An airborne radio beacon transceiver that receives interrogation signals from ATC and selectively replies with a preset identification code or “squawk code” set by the pilot. The squawk code is received by ATC and identifies and appears next to the aircraft on ATC radar.

Trim The smaller control surfaces that affect the *elevators* in such a way as to make it less necessary to hold force continually on the yoke to maintain straight and level flight. Large aircraft also have *aileron* and *rudder* trim.

True airspeed The actual speed of an aircraft through the air after compensating for *density altitude*.

Type certificate A rating based on aircraft strength and purpose that classifies an aircraft as Normal, Utility, or Aerobatic, and under FAR Part 23, limits the maneuvers the aircraft can legally perform.

U

Uncoordinated flight The mode of flight in which the pilot coordinates the *ailerons* and *rudder* (see also *auto-coordinated*).

V

Vertical Speed Indicator (VSI) See *rate of climb indicator*.

Vertical stabilizer The surface of the aircraft that is used to help control motion about the aircraft’s vertical or *yaw* axis.

Visual Flight Rules (VFR) The “rules of the road” that cover flight in those conditions wherein flight can be safely controlled by looking out the window.

VOR Very high frequency Omnidirectional Range. This is a ground-based radio transmitter that provides positive guidance on pilot-selected magnetic course radials or straight lines. It is used in conjunction with the NAV radio and the VOR indicator.

W

Weathervane effect The tendency of the plane to pivot around a pivot point (the center of gravity on an airplane) until the airfoils are in back of the pivot point with relation to the oncoming wind.

Y

Yaw The rotation about the aircraft's vertical or yaw axis.

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Microsoft Corporation
16011 NE 36th Way
Box 97017
Redmond, WA 98073-9717

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